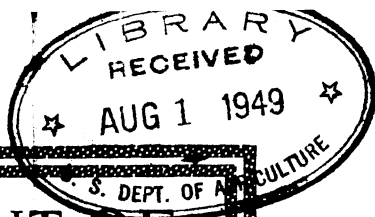


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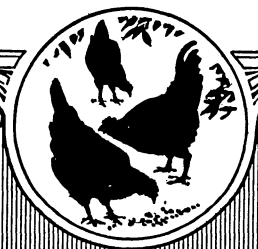
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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1652

DISEASES AND PARASITES *of* POULTRY



CHICKENS, turkeys, ducks, geese, and pigeons are susceptible to many diseases, some of which are highly infectious. Disease germs pass rapidly from bird to bird of the flock, and may be carried by one means or another to neighboring flocks, producing extensive outbreaks, or epizootics.

Poultry are also infested by numerous kinds of parasites, some of which live on the surface of the body and others internally, especially in the crop, stomach, and intestines. These parasites may seriously affect the health of the birds by preventing their nourishment and by causing irritation and inflammation of the parts which they attack.

Certain diseases respond favorably to treatment. Others resist all efforts at treatment and cause heavy losses.

Preventive measures properly applied offer the surest means of controlling diseases of domesticated birds.

The purpose of this bulletin is to inform the poultry owner as to the characteristics of the various diseases and infestations in order that he may intelligently use the most approved methods of combating them. However, it is in no sense intended to replace the valuable services and advice of the trained veterinarian, which, if available, should by all means be obtained.

This bulletin is a revision of and supersedes Farmers' Bulletin 1337, Diseases of Poultry.

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DISEASES AND PARASITES OF POULTRY

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DOMESTIC BIRDS are subject to a considerable number of diseases, some of which spread rapidly through the flock and cause high mortality. They may also be infested by various kinds of parasites, some of which live on the surface of the body and others in various passages or organs within the body. These parasites are

¹ Deceased.

² Revised by Hubert Bunyea, Walter J. Hall, and Eloise B. Cram. C. F. Bishopp, Bureau of Entomology, assisted with the part relating to insects, mites, and ticks.

injurious because they take part of the nourishment which should be used by the bird to put on flesh or to produce eggs, and also because by their movements and other activity they cause irritation and inflammation of the parts they attack.

The contagious diseases which are caused by germs and viruses and the weakness and loss of flesh caused by the larger parasites just mentioned are the most important conditions which the poultryman has to consider in the endeavor to keep his birds healthy. These germs, viruses, and parasites should be kept out of the flock by suitable preventive measures, because disease may be avoided much more easily and cheaply than it can be cured. The aim in studying the diseases of poultry is, therefore, to learn how to prevent the diseases as well as how to control them once they become established.

DISEASE PREVENTION

To prevent diseases, we need to understand something about them. Some diseases are caused by infection; others result from faults of nutrition; and still others are traceable to the general conditions surrounding the flock.³

The first rule of health is sanitation. The observance of this rule comprises the following points: (1) Quarantining of new stock until it is known to be healthy; (2) protecting the flock from access to polluted drinking water, spoiled or infected feeds, or contaminated grounds; (3) burying, burning, or otherwise making proper disposal of diseased carcasses; (4) thoroughly cleaning and disinfecting premises contaminated by disease; (5) protecting the flock from vermin and diseases and parasites carried by free-flying birds; and (6) preventing persons who have unhealthy chickens from entering the poultry yards or houses.

Proper nutrition is the second rule of health. Some diseases are caused by a ration lacking certain elements, while others are due to excessive feeding of some feeds. Rickets, nutritional roup, and polyneuritis are deficiency diseases, whereas obesity and gout are attributed to excesses of unbalanced nutrition. A balanced cereal ration with meat scrap and shell or bone, a regular allowance of green feeds, and clean water, should contain all the vital elements of nutrition required by birds.

The third rule of health is good surroundings; that is, roomy, comfortable, well-ventilated poultry houses, free from drafts or dampness, and with ample provision for exercise, and suitable exposure to the direct rays of the sun.

Large flocks should be divided into smaller units for convenience in care and feeding as well as an aid to disease prevention. Birds of various ages and of different species should, if possible, be kept separate.

DISEASE CONTROL AND ERADICATION

The extensive use, in recent years, of artificial and wholesale methods of incubation, housing, and feeding has increased the

³ Additional information on the correct feeding and housing of poultry is contained in Farmers' Bulletin 1541, Feeding Chickens, and Farmers' Bulletin 1554, Poultry Houses and Fixtures, which may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., price, 5 cents.

opportunity for disease development and transmission at an alarming rate so that disease has become one of the greatest barriers to success with poultry. New and baffling diseases are springing up, and their diagnosis and control are essential.

Normal, healthy chickens do not require drugs of any kind. When an outbreak of disease occurs in a flock the first procedure is to get an accurate diagnosis. This can be done best by the local veterinarian, but if no practicing veterinarian is available, it is a good plan to communicate with the State agricultural experiment station. If the disease proves to be a contagious one, the next step is to remove the sick birds from the flock. Remedies and curative treatments are useless in most of the devastating contagious diseases, and the treatment of sick birds increases the opportunity for the spread of the disease to the rest of the flock. The proper handling of contagious diseases consists in sanitation, preventive treatment, and eradication rather than cure.

Diagnostic tests for pullorum disease and tuberculosis, as well as chicken-pox vaccination, should be conducted by a veterinarian experienced in poultry diseases.

DISINFECTANTS AND THEIR APPLICATION ⁴

Good disinfectants destroy the germs of contagious diseases, and in some cases the external parasites, such as lice and mites. Since the germicidal power of disinfecting solutions is rapidly spent by contact with organic matter it is always important to give special attention to the cleaning of the premises, including the removal of all litter, contaminated soil, and manure before applying the disinfecting solution. The disinfectants should be thoroughly applied to the interior of the houses, worked into all the cracks and crevices, spread over the ceiling and the floor, the roosts, dropping boards, nest boxes, and feeding and drinking vessels. Merely sprinkling the germicide here and there is of little value. Disinfectants are most easily applied to the walls and ceilings with a spray pump or with a brush. As it is difficult to keep them from coming into contact with the face and hands, the mixtures least harmful to persons should generally be used.

In the case of an actual outbreak of virulent disease it is advisable to use for disinfecting purposes a whitewash made by dissolving 1 pound of commercial lye (containing 94 percent of sodium hydroxide) and 2½ pounds of water-slaked lime in 5½ gallons of water. If the solution is not used at once, it should be tightly covered to prevent deterioration. This solution is cheap, odorless, and destructive to almost all kinds of disease germs. By prolonged contact, however, it may be injurious to painted or varnished surfaces, and to some fabrics. It is corrosive for aluminum, but relatively harmless to the metallic fixtures ordinarily found about chicken houses, and to wooden construction or equipment.

The above-mentioned disinfectant solution has been found by experiments to be ineffective against the germs of tuberculosis. For

⁴ Additional information on the subject is contained in Farmers' Bulletin 926, Some Common Disinfectants, and Farmers' Bulletin 954, The Disinfection of Stables, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., price, 5 cents.

combating that infection the chicken houses, enclosed runs, and all eating, drinking, and other utensils should be thoroughly cleaned and disinfected with a strong solution of such germicides as carbolic acid, or compound solution of cresol. Carbolic acid may be used in 5-percent solution and compound solution of cresol in 3-percent solution.

Kerosene emulsion is frequently used to destroy mites. To make the emulsion, shave half a pound of hard laundry soap into half a gallon of soft water and boil the mixture until all the soap is dissolved; then remove it to a safe distance from the fire and stir into it at once, while still hot, 2 gallons of kerosene. This makes a thick, creamy emulsion or stock mixture. When it is to be used for killing mites in the houses, 1 quart of this emulsion is mixed with 10 quarts of water.

A further means of freeing premises from infection by most germs and parasites is to keep them free of fowls for several months, or a year if possible. The sun's rays will destroy most disease organisms directly exposed to them in a short time, and by this means fields and yards are eventually disinfected to a large extent. There are many dark or covered places not reached by the direct rays of the sun, however, and in such spots germs may survive for several months. In the case of highly resistant forms of infection, such as oöcysts of coccidia, disinfection in addition to vacating the premises is a desirable safeguard. It is advisable to place new stock on ground which has not been occupied by poultry for a year or more.

When the runs are heavily contaminated with disease germs, or infested with the eggs of poultry parasites, much added protection can doubtless be given the flock by scaling off the surface of the run to a depth of 4 inches or else liming it and spading or plowing it under to a good depth.

NUTRITIONAL DISEASES

NUTRITIONAL ROUP (VITAMIN A DEFICIENCY)

Nutritional roup is a disease of chickens resembling roup in appearance but it is due to a deficiency of fat-soluble vitamin A in the ration.

This food element is obtainable from many sources, such as cod-liver oil, butterfat, green feeds, raw carrots, tomatoes, and egg yolks. On being supplied with feeds containing vitamin A in sufficient quantities, fowls affected with nutritional roup usually recover.

POLYNEURITIS (VITAMIN B DEFICIENCY)

Polyneuritis is a nutritional disease affecting birds of any age, although young birds are most susceptible.

The condition is due to a deficiency of water-soluble vitamin B in the ration. This food substance is present in many green feeds and whole grains. A ration restricted to degerminated grain is not suitable for poultry.

The symptoms of polyneuritis are loss of appetite, emaciation, leg weakness, and spasmodic movements of the head or limbs.

Treatment.—Treatment consists simply in the feeding of mixed whole grains and green feeds, together with a mash in which meat or fishmeal is included.

GOUT

Gout is caused by the presence of an abnormal quantity of uric acid in the blood, which results in the deposit of urates on the internal organs (visceral gout) or occasionally in the joints (articular gout).

Cause.—Pullets are sometimes placed on a high-protein laying mash too young, or fed protein feeds of poor quality. The increased quantity of uric acid may be induced also by prolonged feeding on substances rich in protein, especially if associated with lack of exercise, or diseases which affect the urinary organs, causing a failure to eliminate the uric acid properly.

Symptoms.—In articular gout the joints of the feet and wings may be involved. At first the joints are swollen and painful. The lesions then form into nodular, tumorlike growths which may later burst, discharging a yellowish, turbid material containing urates. The bird remains sitting as much as possible. The general health becomes affected, and emaciation gradually occurs, with weakness and frequently diarrhea.

Visceral gout is apparent on autopsy only. The internal organs and serous membranes are found covered with chalklike deposits, particularly the heart and the inside of the heart sac. The kidneys and ureters are frequently swollen, pale, and engorged with urates. The course of the disease is slow.

Treatment.—Artificial Karlsbad salt has been beneficial. This is prepared by mixing together sodium sulphate 22 grams, potassium sulphate 1 gram, sodium chloride 9 grams, and sodium bicarbonate 18 grams. Six grams (or one fifth of an ounce) of this mixture is added to each quart of drinking water. Tincture of colchicum in from 2- to 5-drop doses may be administered to affected birds. (Enlarged joints may be opened and the contents washed out.) The diet should be corrected. Often a reduction in the quantity of meat scrap and an increase in green feed will prevent additional cases. The entire flock should receive a dose of Epsom salt, one third teaspoon to each adult bird.

RICKETS (RACHITIS, VITAMIN D DEFICIENCY)

Rachitis (rickets) is a disease of the bones of growing fowls caused by a deficiency of vitamin D in the diet. This deficiency results in failure of the bird to obtain sufficient lime salts from the feed to build strong bones. The bones are soft and deformed, as is frequently shown in chickens with crooked legs or crooked breasts. Catarrh of the intestines sometimes occurs.

To aid in overcoming a tendency to rickets in chicks give 2 percent of fresh cod-liver oil in the mash. Direct sunlight (not through window glass) is also highly efficacious in preventing rickets. Glass substitutes, said to permit the passage of the antirachitic sun rays, may now be obtained on the market. These products are replacing glass on many poultry farms. Growing birds should receive a varied ration, including green feeds, and a supply of ground oyster shell or limestone grit and bone.

DEFORMING LEG WEAKNESS (PEROSIS, SLIPPED TENDON, HOCK DISEASE)

Deforming leg weakness is a disease of growing chicks reared in confinement. This disease should not be confused with rickets,

as it appears in spite of an abundance of vitamin D. Present knowledge indicates that it is due to an improper calcium-phosphorus ratio, and possibly also to a deficiency in some vitamin or vitamin fraction. The disease usually appears between the ages of 3 and 7 weeks, and often affects the best-developed chicks.

Symptoms.—The first symptoms noticed are a slight puffiness of the tissues about the tibiotarsal (hock) joint and discoloration due to subcutaneous hemorrhage. This stage is known as "enlarged hocks", and if it does not go beyond this stage the bird may recover without permanent deformity. During this stage bending of the distal end of the tibia or the proximal end of the metatarsal bone may occur, which permits the Achilles tendon to slip from the condyles to either the inside or outside of the joint, causing the chick to become knock-kneed or bowlegged. Contraction of the tendon increases the deformity by further bending of the bones and causes permanent flexion of the leg so that the chick is unable to walk at all, and it sits or hops about on the hocks. This results in bruising of the joint and frequently rupture of the synovial sac and joint infection.

Control.—Control consists in prophylaxis rather than treatment as it cannot be cured after the deformity has occurred. This condition may be largely prevented by the feeding of a balanced diet in which is included 5 to 10 percent of rice bran, or about 20 percent of wheat middlings.

OBESITY

Obesity is an abnormal state of fatness and plethora induced by prolonged heavy feeding of starchy feeds, with insufficient exercise. It sometimes offers mechanical interference to egg laying and tends to cause rupturing of egg yolks or of the liver, leading to death. Obesity may retard other body functions, such as circulation of blood, digestion, and assimilation of feed. The heavier breeds are more susceptible.

Treatment.—Feed grain in moderate allowances. Encourage exercise. Temporarily reduce starchy ingredients of mash, and supply green feed or sprouted oats.

INFECTIOUS AND CONTAGIOUS DISEASES

DISEASES CAUSED BY SPECIFIC GERMS

PULLORUM DISEASE (BACILLARY WHITE DIARRHEA)

Pullorum disease (bacillary white diarrhea) is quite widespread, existing in every section of the United States where appreciable numbers of poultry are kept. It causes heavy financial losses, resulting from the deaths of baby chicks, diminished egg production in hens and pullets, reduced hatchability of eggs, and occasionally the deaths of hens due to generalized pullorum infection. Fortunately pullorum disease does not attack other species of domestic fowls to any serious extent.

Cause.—The disease is caused by a toxin-forming germ which is known as *Salmonella pullorum*. Although this germ is quite easily destroyed by direct sunlight, heat, or disinfectants, it has been known

to remain alive in soil or manure in sheltered places for many days, or even months. The primary seat of pullorum infection is the ovary of the infected hen.

Mode of dissemination.—The disease is commonly transmitted from the hen to the chick by means of the egg (fig. 1). All eggs laid by an infected or "carrier" hen do not contain the organism, *Salmonella pullorum*, but infected eggs, if hatched, produce infected

chicks. Such chicks may die of the disease any time during the first 3 weeks of their lives, or they may survive to maturity and repeat the cycle (fig. 2) by themselves producing eggs and chicks infected with the organism. Chicks having the disease are constantly voiding enormous numbers of the germs in their droppings, thereby spreading the infection. The hatching of infected eggs in an incubator or under a hen may result in the transmission of the disease to other chicks hatched from uninfected eggs in the same incubator or brood. Infected chicks placed in a brooder house with healthy chicks will spread the disease. In the case of the hatchery chicks, however, the danger of acquiring the disease is multiplied by the fact that the eggs for hatching are frequently assembled from a number of flocks, and if one or more of these flocks happen to be harboring the infection, the entire output of the incubator is exposed to the menace of the disease. Many progressive hatcherymen have already realized the importance of taking the initiative in protecting their customers from pullorum disease by requiring the flocks which supply them with eggs to be tested for the presence of pullorum-disease carriers.

Symptoms.—In hens and pullets pullorum disease is limited as a rule to the egg-making organs, and consequently produces no outward symptoms. It may, therefore, exist unsuspected in a flock. In chicks the symptoms of the disease and the deaths which it causes are sometimes wrongly attributed to some other cause, such as fungous pneumonia (aspergillosis), chilling, or overheating. The presence of the disease may be recognized by the following principal



FIGURE 1.—a, Normal ovary of fowl; b, ovary affected with *Salmonella pullorum*. (After Rettger.)

characteristics, although a definite diagnosis cannot be made from these alone. In order to diagnose definitely the disease in chicks, clinical observations must be confirmed by bacteriological proofs.

Pullorum disease is observed in chicks from the time of hatching until they are about 3 weeks old. The chicks may die suddenly after having shown but slight symptoms for a short time. Generally, however, they will first seem disposed to huddle together, or remain too much of the time under the hen or the hover. They soon appear drowsy and indifferent to their surroundings. They stand about with closed eyes and ruffled plumage, listlessly picking at their feed from time to time, but apparently not eating it. Their droppings may be whitish, foamy, and sticky, or sometimes brownish in color. Hence the name "bacillary white diarrhea" is in some cases an inaccurate description of the disease. Sometimes the excrement sticks

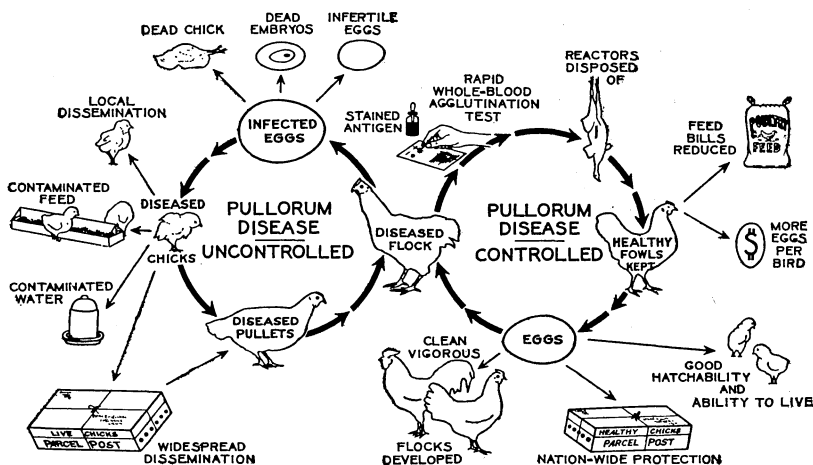


FIGURE 2.—Graphic comparison of serious effects of uncontrolled pullorum disease with the benefits resulting from the use of the agglutination test and the disposal of reactors.

to the down in the region about the vent and accumulates until it completely covers and plugs the opening. This condition, known as "pasting up behind", unless soon relieved, will quickly cause the death of the chick. When attempting to void the excrement the sick chicks utter shrill cries of pain. Labored breathing signals the approach of death, which may then come quickly, or after a period of extreme prostration. The death rate in infected broods may range from 50 to 80 percent.

Post-mortem appearance.—In hens and pullets the outstanding change brought about by the disease is that seen in the ovary. In making an autopsy of fowls that have died, or when preparing fowls for the table, the ovaries should be examined for lesions of pullorum disease. In an infected ovary the partially or wholly developed yolks are angular in outline, shrunken, hard, and of an abnormal brownish or greenish color (fig. 1, b). At times yolks containing dark fluid are observed. The presence of *Salmonella pullorum* can usually be determined in the diseased ova by laboratory methods.

In chicks dead from pullorum disease the presence of noticeable changes depends somewhat upon the age of the chick at death. Those from 1 to 5 days of age often fail to show visible internal evidences of the disease. Chicks dying at 6 days of age and upward very often show small necrotic spots, like whitish deposits, in the lungs, in the muscles of the heart, and possibly on the outer surface of the intestines. The absence of any pathological changes on autopsy does not, however, mean that the disease is not present. The germs sometimes inhabit practically every organ in the chick's body, but they are most frequently recovered from the heart, liver, lungs, the unabsorbed portions of yolk, and from the blood. Determining the presence of this infection in fowls of any age requires special training as well as the use of equipment and materials not generally available outside the laboratory. It is usually possible to have an expert examination made of suspected cases of pullorum disease at any of the State agricultural experiment stations.

Control.—There is no medicinal treatment, or method of vaccination which is of known value in the prevention or cure of pullorum disease in chicks or hens. The very nature of the disease renders treatment both futile and undesirable. Flocks which harbor the infection should not be used for breeding purposes. The cycle of infection established by the hen, the egg, the recovered baby chick, and the pullet (fig. 2) indicates that it is not advisable to save for breeders any chicks which have been exposed to an outbreak of pullorum disease. Hens which harbor the infection in their ovaries are likely to lay infected eggs from which diseased chicks will be hatched. The only practicable means of controlling pullorum disease, therefore, is to detect the carrier hens and eliminate them from the breeding flock.

Methods of diagnosis of pullorum disease.—Various methods have been developed for the detection of carriers of pullorum disease in flocks. The decision as to which method shall be adopted in a given case will depend largely upon the kind of service available.

The agglutination test.—Three different forms of agglutination tests are in use at the present time: (1) The long method, or tube test, (2) the rapid serum method, and (3) the rapid whole-blood method. For practical purposes these three methods may be considered equally reliable for the detection of pullorum-disease carriers.

The long method, or tube test.—This method of testing is strictly a laboratory procedure and is not adaptable to field use. A small sample of blood is collected from each fowl to be tested, and the clear serum is allowed to separate from the clot. A proportionate amount of the serum is mixed with an antigen consisting of a standardized suspension of *Salmonella pullorum* organisms. After thorough agitation the mixture is incubated for 1 to 2 days, and finally examined for the presence of an agglutination reaction, which is manifested by the clearing of the fluid and clumping of the bacteria in the bottom of the test tube, indicating that the hen is infected with the germ of pullorum disease. In negative cases there is no clearing of the mixture, and no clumping of the bacteria.

The rapid serum test.—Although this method is essentially a laboratory procedure, it may, with certain preparations, be made adapt-

able to field use. With this method the undiluted clear serum of the fowl to be tested is mixed with a highly concentrated antigen on a glass plate or slide, over an illuminated dark background. The antigen employed is a standardized suspension of *Salmonella pullorum* in a concentrated solution of sodium chloride preserved with phenol. For the test, a pane of glass forms the top of a black-lined box illuminated by a frosted incandescent bulb within. The two substances are mixed by the aid of a toothpick. The reaction may occur immediately, or may require several minutes. A positive reaction consists in the formation of visible clumps of the bacteria and a clearing of the intervening fluid. A negative test remains uniformly cloudy, without any clumps forming.

The rapid, whole-blood test.—This test is somewhat similar in its mechanism to the rapid serum test previously described, but owing to its simplicity and facility of operating, it is well adapted to field use. Outstanding advantages of the rapid, whole-blood test are as follows: (1) The use of a single drop of fresh, whole blood immediately after it is obtained from the fowl; (2) the stained antigen, which makes it easy to detect reacting cases over a white background without artificial illumination; and (3) the fact that the presence or absence of pullorum infection is immediately diagnosed with one handling of the fowl and reactors are disposed of at the time of the test, eliminating the necessity of banding the fowls.

The antigen for the rapid, whole-blood test is composed of a heavy suspension of *Salmonella pullorum* in physiological saline solution preserved with formalin, and stained with crystal violet.

In the application of this test a drop of blood is obtained by pricking the wing vein with a sharp-pointed instrument. The drop of blood is picked up with a wire loop and immediately mixed with one drop of stained antigen on the test glass or plate. The antigen is usually placed on the glass first, and the drop of blood is added to it. With the same wire loop, the antigen-blood mixture is stirred for a moment and then spread out on the glass to a diameter of about 1 inch. When the glass is rocked from side to side a few times, over a sheet of plain paper or other white background, the agglutination usually becomes visible in from 5 seconds to 2 minutes in reacting cases. The loop is then rinsed in clean water and dried on a clean towel in preparation for the next test.

The intradermic test.—This method consists in injecting into the wattle a small amount of a diagnostic agent prepared from a broth culture of *Salmonella pullorum*. In applying the test, the fluid is injected between the layers of the skin, slightly above the lower border of the wattle. In reacting cases an edematous swelling of the injected wattle similar to that produced by the intradermic tuberculin test (fig. 4) appears in approximately 24 hours.

FOWL CHOLERA

Fowl cholera is a highly infectious, rapidly fatal disease of all domesticated birds. Birds of any age are susceptible.

Cause.—It is caused by *Pasteurella avicida*, a germ which multiplies to enormous numbers in the blood and various organs of the body, producing a septicemia or blood poisoning. The disease is

carried by sick or recently recovered birds which have been placed in a healthy flock, by wild birds, or by persons, animals, or poultry utensils which have been on infected premises. It spreads rapidly throughout the flock, owing to the fact that the first birds to become infected give off great numbers of the germs in their droppings and these are picked up by the other birds in feeding and drinking.

Symptoms.—The first symptom is a yellowish coloration of the droppings. This is followed by yellowish, brownish, or greenish diarrhea. The bird becomes droopy, feverish, and sleepy and sits with the head drawn down to the body or turned backward and resting in the feathers about the wing. Appetite diminishes, and thirst increases. Breathing becomes difficult and may be heard at some distance. Finally the weakness is such that the bird cannot stand but lies with the beak resting on the ground. It sleeps so soundly for some time before death that it can hardly be aroused. The comb and wattles may be a dark-bluish red, and the skin of the breast and abdomen is frequently reddened.

In very acute cases no symptoms are seen; the birds may be found dead under the roosts or they may fall while feeding or moving about and die in a short time. During an acute outbreak sickness is seldom noticed more than 24 hours before death, which usually occurs within 3 days of the time of infection.

Cholera may destroy the greater part of a flock in a week and then disappear, or it may linger in a chronic form for months, only occasionally killing a bird. The chronic form is characterized by a continually increasing weakness, loss of weight, paleness of head, and finally an exhausting diarrhea. Sometime one or more joints of the wings or legs swell, the bird becomes lame, and later the swellings break and discharge a creamy or cheesy mass.

Post-mortem appearance.—The heart has red spots or hemorrhages on its surface. The first portion of the intestines is congested and hemorrhagic, and the contents consist of a pasty mass, which may be bloodstained. The vessels of the visceral organs are congested. The liver may be enlarged and darker in color and the spleen may be swollen. A sticky fluid is frequently present in the mouth and nostrils.

Control measures.—Since treatment of affected birds is futile, the aim should be to prevent so far as possible the spread of infection. The first fowls showing acute feverish symptoms should be destroyed by a method which will guard against the contamination of the premises by infected blood. The carcasses should be burned or buried deeply. The healthy fowls should be moved to new quarters, if possible, and carefully watched for signs of the disease. Houses and runs should be thoroughly cleaned at frequent intervals and disinfected with a reliable disinfectant in proper dilution. The drinking water may be made antiseptic by adding one third teaspoon of permanganate of potash to each gallon, a procedure which tends to check the spread of disease by means of the water.

Too much dependence, however, should not be placed on the permanent effectiveness of antiseptics in drinking water. If the feed or water supply of the fowls becomes contaminated, it should be removed and a fresh clean supply substituted.

EDEMA OF THE WATTLES

Edema of the wattles is a local swelling caused by their filling up with a dropsical fluid. The condition is caused by a localized infection with the germ of fowl cholera. Although the death rate from this disease is not high, the birds thus affected (principally males) are weakened and thus rendered comparatively defenseless against the attacks of more vigorous birds.

Keeping an antiseptic, such as permanganate of potash, one third teaspoon to each gallon, in the drinking water is of some value in checking the spread of the disease by that means. The cropping (surgical amputation) of the wattles has been found to be more practical, however. The wattle is grasped firmly with a strong-jawed clamp and severed with clean scissors. Before the clamp is removed, the cut edges of the stump should be painted with tincture of chloride of iron to prevent hemorrhage. A dusting powder of equal parts of calomel and powdered burnt alum may be applied later to prevent subsequent hemorrhage or infection. The bird should be isolated, if possible, until the wounds are healed.

FOWL TYPHOID

Fowl typhoid is an infectious disease of mature chickens which has rarely been observed in other domestic birds. It attacks the blood and internal organs.

Cause.—The disease is caused by *Salmonella gallinarum*, a micro-organism which is introduced on the premises by carriers, such as infected fowls, material from infected poultry yards, or free-flying birds, or on the feet of persons or animals which have been on infected premises. Fowl typhoid spreads through a flock in a manner similar to fowl cholera and most of the other infectious diseases, but is not so destructive as the acute form of cholera.

Symptoms.—These are drowsiness, fever, loss of appetite, and general weakness. The droppings are soft and yellowish or greenish. The membranes of the head, comb, and wattles are usually paler than normal, but in acute cases may be darkened with venous congestion. Complete prostration may develop in from several hours to 1 or 2 days before death. Symptoms become noticeable in from 4 to 6 days after infection takes place and last, in fatal cases, from 4 to 12 days.

Post-mortem appearance.—The internal parts of the body other than the liver and the spleen have a pale appearance. The mucous membrane or interior lining of the intestine is usually pale. The blood is thin, pale red in color, and does not clot readily. The liver is greatly enlarged and generally dotted with grayish spots. It has a tendency to break easily. The spleen is often swollen, pulpy, and filled with grayish spots. The kidneys are somewhat enlarged and lighter in color or slightly congested. The heart appears normal or pale, with grayish spots on its surface.

Control measures.—The measures advised for cholera apply also to typhoid since medicinal treatment is of no value.

AVIAN TUBERCULOSIS (FOWL TUBERCULOSIS)

Avian tuberculosis is a chronic, infectious disease of domestic and wild birds. It is most common, however, in the fowl and pigeon. It

is readily contracted by pigs, rats, and mice, but man is rarely affected by avian tuberculosis. Parrots and canaries are quite susceptible to human tuberculosis, but fowls are practically insusceptible.

Cause.—The disease is caused by *Mycobacterium tuberculosis avium*. Tuberculosis is generally brought into the poultry yard with fowls that are purchased from infected flocks. If the disease exists in neighboring flocks the contagion may be carried by small birds, animals, or persons passing from one yard to another. A peculiarity of tuberculosis of birds is that the liver and intestines are nearly always very severely affected, and that as a consequence the organisms are very numerous in the intestinal contents and are scattered with the droppings. The introduction of a single diseased bird, therefore, may cause the infection of the greater part of the flock in a few weeks. In the same way, when wild birds contract the disease, the germs are carried and deposited in yards which they visit.

Pigs, rats, and mice are especially liable to be infected with fowl tuberculosis by eating the carcasses of birds which have died of it, and these animals serve to keep up the contagion and may communicate it to other fowls, especially if the latter eat the carcasses of rats or mice that have died of the disease.

Symptoms.—Although birds may become infected at any age, the disease usually progresses slowly, and symptoms are generally not observed until the affection has reached an advanced stage. Hence it is the older fowls, those more than 1 year of age, which display the most pronounced symptoms and show a high death rate.

Signs of disease begin with gradual loss of weight, wasting of the muscles, especially noticeable in the breast, paleness of the comb, and toward the end, dullness, sleepiness, and diarrhea with yellowish or greenish droppings. Very often there is at the same time a tuberculous inflammation of the joints and of the sheaths of tendons, which is revealed by lameness and swelling of the joints and legs. Occasionally the skin over the swollen joint breaks, the interior of the joint is ulcerated, and a small quantity of cheesy material is discharged. Deaths in the flock occur at intervals. Affected birds may live only a short time after symptoms are noticed, or they may live for weeks.

Post-mortem appearance.—On post-mortem examination grayish-white or yellowish tumors of varying sizes are observed in the internal organs, but especially in the liver (fig. 3), spleen, and intestines. These tubercles when cut open present a solid, grayish, glistening interior which in the larger ones exhibits yellowish centers or a number of yellowish points. Those of more advanced growth show extensive, yellowish, cheesy, or crumbly masses in their interior.

Distinguishing tuberculosis from other diseases.—The diseases which may be confused with tuberculosis of birds by similarity of lesions are: Tumors or cancers of the abdominal organs, tapeworm nodules in the intestine, fungous condition of the lungs, blackhead of turkeys, blood poisoning which produces an enlarged, spotted liver, leukemia (big-liver disease), or gouty swelling of the joints. These diseases are described elsewhere in this bulletin. The prominent lesions of the conditions mentioned are usually limited, however,



FIGURE 3.—Tuberculous organs of fowl. Note whitish spots on liver and its greatly enlarged condition.

weeks. The fluid must be injected, by means of a small-caliber syringe with a 26- or 27-gage needle, into the deeper layer of the skin of the wattle. Slightly less than 1 drop, about one twentieth of a cubic centimeter, is forced into the skin just beneath the surface, and not deep enough to penetrate the skin or enter the underlying connective tissue of the wattle. Only one wattle is injected, the other being left for comparison. Forty-eight hours after the injection, a swelling in the wattle indicates a positive reaction and the presence of tuberculosis in the fowl (fig. 4). A

to certain specific organs instead of being spread to the variety of organs attacked in tuberculosis. A definite diagnosis may be had in all cases by microscopic examination of the disease processes. Avian tubercles contain extremely numerous tubercle organisms which are readily seen in laboratory examination.

Testing fowls for tuberculosis.—Diagnosing tuberculosis in living fowls is possible by means of the intradermic tuberculin test. The test fluid used is prepared from bouillon in which avian tubercle bacilli have grown for several



FIGURE 4.—Fowl showing swollen wattle, following tuberculin test, indicating the presence of tuberculosis.

high percentage of tuberculous fowls in a flock may be detected by this test, which should be applied by a qualified veterinarian.

Prevention and eradication.—No treatment will cure tuberculous birds. The most thorough method of eradication is to slaughter the entire flock when indications point to an extensive outbreak. Fowls in good flesh, showing no lesions or slight ones, may be used for food, provided all affected organs and parts are removed and the meat is thoroughly cooked. Those badly diseased and all visceral organs of the others should be destroyed.

The chicken houses, enclosed runs, and all eating, drinking, and other utensils should be thoroughly cleaned and disinfected as previously specified. After disinfection the premises should be kept free of fowls for a year, if possible, or new stock may be placed on ground which has not been occupied by poultry for a year or more. In restocking, obtain birds or eggs for hatching from flocks which have shown no signs of an infectious disease for a year or more. When the breeding value of the fowls makes it undesirable to dispose of the entire flock by slaughter, tuberculosis may be controlled and even totally eradicated by supplementing the customary culling measures with the tuberculin test and sanitation. As has been stated, the disease develops very slowly, and for that reason it is advisable to dispose of all birds when they reach the age of 18 months, or at the end of the first laying period. From an economic standpoint also this is sound policy, as the egg yield decreases after the first year of laying. Younger birds should be disposed of whenever they appear to be abnormal. This procedure alone will greatly assist in holding tuberculosis in check.

APOPLECTIFORM SEPTICEMIA

Apoplectiform septicemia is a rapidly fatal disease of chickens, turkeys, pigeons, and other fowl which is caused by the germ *Streptococcus capsulatus gallinarum*.

Symptoms.—Symptoms may consist of depression, inappetence, listlessness, staggering gait, and finally prostration and death. However, the progress of the disease is so rapid that death may occur without noticeable symptoms.

Post-mortem appearance.—There is usually a discoloration of the skin of the breast and neck caused by subcutaneous hemorrhages. Serous or bloody exudates may be seen in the heart sac and body cavity. The liver, spleen, and kidneys may be greatly swollen, and in addition a false membrane may be spread over the surface of the liver. The intestines are thickened and congested, with bloody contents. The lungs may be congested or pneumonic.

Control.—Observe the sanitary precautions outlined early in this bulletin. Healthy fowls may be successfully vaccinated against apoplectiform septicemia by the intravenous injection of a killed culture of the causative organism.

DISEASES CAUSED BY FILTRABLE VIRUSES

CHICKEN POX (DIPHTHERIA)

Chicken pox and diphtheria are but external and internal manifestations, respectively, of the same disease. The virus which causes

the formation of warts or pox nodules on the head, typical of chicken pox, also causes the cheesy patches in the mouth and eyes which are characteristic of diphtheria. Chickens and pigeons are most frequently affected, but turkeys and birds generally are susceptible.

Cause.—Chicken pox is caused by a virus which passes through laboratory filters and cannot be seen even with a powerful microscope. The disease is strictly infectious and never develops as a result of exposure to dampness and drafts alone, although these conditions favor its spread and tend to increase its malignancy. The contagion is introduced and disseminated in a flock in the same manner as fowl cholera. It is probable that biting insects, such as mites, also spread infection, through inoculation, from sick to healthy birds.

Symptoms.—The disease has the general symptoms of roup but is distinguished from it by an eruption of pox nodules on the head and by the presence, in the mouth, throat, and eyes, of tough, cheesy patches which are firmly attached to the tissues beneath them (fig. 5).



FIGURE 5.—Chicken-pox nodules on comb, on wattles, and near corner of mouth. (After Hutýra and Marek.)

The eruption appears as round, oblong, or irregularly shaped nodules from the size of a pinhead to that of a pea or a hazelnut. It is seen especially about the beak and nostrils and on the comb, the eyelids, the wattles, and the ear lobes. In some birds, particularly in pigeons, the eruption is more generalized and is found on the skin of other parts of the body, as the neck, under the wings, on the rump, and about the vent. Here the nodules may become larger than on the head. The nodules begin as small, red, or reddish-gray growths with a shiny surface and gradually enlarge, while the color changes to a yellowish,

brownish, or dark brown, and the surface dries and becomes shriveled, uneven, and warty in appearance. Owing to the number of nodules and the extension of the inflammation, large patches of skin becomes thickened and covered with hard, dry crusts, closing the nasal openings or the eyelids, and making it difficult to open even the beak.

The severity of the disease depends much on the extent of the internal diphtheritic deposits (fig. 6). These are at first thin, yellowish or whitish in color, and gradually become thicker, firmer, and more adherent, so that considerable force is required to remove them. The mucous membrane beneath the deposit, when the latter is removed, is found to be inflamed, ulcerated, and bleeding, but it is soon covered by a new deposit. This exudate is called a false membrane, and when it is situated where the breathed air passed over it, it dries, becomes uneven and fissured, and its color changes

to a dark brown. In pigeons the exudate is more friable and easily removed, and the mucous membrane beneath it is reddened but not ulcerated.

While the false membranes over the parts first affected are becoming thicker, the inflammation extends to the adjoining surfaces, and new diphtheritic centers develop, uniting with one another until the cheeks, tongue, palate, throat, and inside of the nostrils are covered. Very often the inflammation extends from the nostrils to the eyes, and sometimes it penetrates the air tubes to the lungs, or the gullet to the crop. When false membranes form in the gullet, crop, and intestines there is a rapid aggravation of the symptoms, such as intense diarrhea, and the escape of blood with the droppings. This type of the disease is more frequent in waterfowl than in other birds. Some fowls in a flock are resistant, and after a few days of illness rapidly recover. Others remain dull, weak, and thin in flesh, and may have more or less catarrh and difficulty of breathing for a long time.

The period between exposure to the contagion and the appearance of the first symptoms varies from 3 to 15 days. The duration of the disease varies from 2 or 3 days to as many weeks in the acute cases, while the chronic form may continue for several months.

Treatment.—The treatment of fowls severely affected with diphtheria requires much time and patience, and as a rule does not pay. It is often better to kill the birds, bury or burn their carcasses, and disinfect the poultry houses, and in that way eradicate the contagion as soon as possible.

If it is decided to treat the sick birds they should be removed from the flock and put into a comfortable, well-ventilated room that may be easily disinfected. Make a solution by dissolving 2 drams of common salt in a quart of warm water, and with a soft brush or a pledget of absorbent cotton dipped in this solution gently brush or rub the false membranes until they are disintegrated and loosened from the underlying tissues. Sometimes it is necessary to scrape them off with a spoon or knife, but it must be done carefully, so that bleeding will not be caused or the sensitive tissues injured. After the false membranes are removed, wet a pledget of absorbent cotton in tincture of iodine or in a 5-percent solution of carbolic acid and apply it for a moment or two to the diseased surface. Another solution which may be used is made by dissolving 2 drams of permanganate of potash in a pint of water. A very good solution consists of $1\frac{1}{2}$ ounces of boric acid and 1 ounce of powdered borax (borate of soda) dissolved in 1 quart of water and applied warm. The two



FIGURE 6.—Diphtheria. Neck slit open to show diphtheritic patches in mouth and esophagus. (After Rätz.)

last-mentioned solutions may be used to wash the eyes or may be injected into the nostrils. Argyrol may also be used as recommended in roup. If large swellings appear beneath the eyes they should be opened with a clean, sharp knife, the contents of the cavity removed, and the space frequently washed with the boric acid-borax or permanganate of potash solution.

The external lesions of this disease may be treated successfully by simple local applications. The crusts on the nodules are softened with carbolated ointment, glycerin, or oil, and after an hour or two removed by washing with warm water containing a little soap. The denuded tissue is then treated with a 5-percent solution of carbolic acid or with tincture of iodine.

As this disease is contagious, the houses, drinking vessels, and feed troughs should be kept disinfected during the outbreak and for several days after all the birds have apparently recovered. The drinking water is made antiseptic by dissolving one third teaspoon of permanganate of potash in each gallon.

Chicken-pox vaccine is used for the prevention of the disease. In order to diminish the possible interference with the productivity of the flock, the birds should be vaccinated at 3 to 5 months of age. Vaccination of a flock of poultry is not recommended, however, under any circumstances, unless the disease has been known to exist on the premises, or the owner considers that his flock is in danger from infection in neighboring flocks. Neither should chickens be subjected to the ordeal of vaccination when in a debilitated, sickly condition, or when heavily infested with parasites. Show birds or those in egg-laying contests should be immunized against pox 6 weeks before being sent to exhibitions or contests.

Favorable results are obtained with the cutaneous vaccination method, which has been in use for several years. This procedure consists in plucking away several feathers from the front part of one leg, and, with a cropped, bristle brush, or other suitable applicator, rubbing the vaccine into the disrupted feather follicles. Another method is to prick through the skin of the bird with a guarded knife point or scissors blade which has just previously been dipped into the vaccine.

Some investigators in Europe and the United States have advocated the use of the virus of pigeon pox for the vaccination of chickens against chicken pox, claiming for this method the establishment of a satisfactory immunity with no appreciable disturbance of health or egg production.

INFECTIOUS BRONCHITIS (INFECTIOUS LARYNGOTRACHEITIS, INFLUENZA, "FLU")

Infectious bronchitis is observed among chickens during the fall and winter months, especially in the large, central poultry-feeding establishments of the Middle West, and during the shipment of the fowls by rail to the principal poultry markets.

Cause.—The disease is caused by a filtrable virus.

Symptoms.—Difficulty in breathing causes the bird to extend the head and open the beak for each respiration (fig. 7), and there is usually a rattling noise caused by obstruction of the windpipe. The

bird becomes ruffled and unkempt. The facial expression is distressed. Appetite rapidly diminishes. Sticky exudates in many cases are present in the mouth and nasal cavity.

Affected birds may recover, although many die within 3 or 4 days after exposure, or may succumb after a week or 10 days. Death is usually caused by asphyxiation from the mechanical obstruction of the windpipe with dry, cheesy exudates. These are, as a rule, more darkened and fibrinous than those of avian diphtheria, and are found only in the air passages.

Post-mortem appearance.—Autopsy reveals no significant lesions except an inflammation of the nasal tract and windpipe, which are obstructed with a mucopurulent or fibrinous exudate, frequently tinged with blood.

Treatment.—No satisfactory flock treatment is known. Individual cases have been benefited by the repeated removal of the dried exudative plug from the windpipe, and placing the sick birds in small groups in warm but well-ventilated quarters.

Control.—The control of this disease is favored by the application of such measures as cleaning and disinfecting the premises, isolating or destroying all sick birds, burying or burning all carcasses, and providing comfortable, spacious, and well-ventilated quarters for the flock.

The eradication of the disease necessitates the rigorous application of sanitary and hygienic precautions. The essential points of a plan of eradication of infectious bronchitis which is in use in Massachusetts are given in the following paragraph. This plan is especially adaptable to isolated outbreaks of the disease, or outbreaks occurring in areas where the poultry population is small or segregated in remote units.

Gather the required number of eggs for hatching, and then dispose of the entire breeding flock which has been exposed to or affected with the disease. Cleanse and disinfect incubators and brooders, and remove them to a safe distance from the disease-infected premises. Use every sanitary precaution in hatching the eggs and brooding the chicks. Cleanse and disinfect buildings and equipment used by the diseased flock as soon as possible after their removal. Then open the doors and windows, allowing the air and sunshine to enter and let the houses remain vacant for 2 months or longer. No clothing or footwear worn around the diseased flock or their premises should be worn when working with the chicks for restocking, unless such apparel has been thoroughly cleansed or disinfected. Introduce new stock only from flocks known to be free of the disease, or raise chicks from your own safeguarded hatches. Safeguard the



FIGURE 7.—Hen affected with infectious bronchitis, showing typical appearance due to difficult breathing. (Photo by J. R. Beach.)

flock from the introduction of the disease by chickens from diseased flocks, visitors from contaminated localities, hucksters, stray dogs, and similar causes.

FWL PEST

Fowl pest, also known as European fowl pest, is a very acute infectious disease. It is of rare occurrence in the United States, only a few outbreaks having thus far occurred in this country. All were eradicated. The disease affects particularly chickens, turkeys, and geese. Blackbirds, sparrows, owls, hawks, and other birds also contract the disease, but wild waterfowl and pigeons are resistant. Mammals, including human beings, are not susceptible.

Cause.—The infective agent is a filtrable virus which is present in the blood and various tissues of the bird.

Symptoms.—The disease is characterized by its extremely infectious nature, rapidly progressing course, and high mortality. The infected fowl loses its appetite, has an irregular gait, and becomes very droopy. The feathers are ruffled, and there is considerable prostration, with swelling and darkening of the comb and wattles. A sticky exudate may paste the eyelids together, clog the nasal passages, and even obstruct the windpipe, causing labored breathing. Some affected birds shake their heads periodically in order to dislodge this mucous secretion from the throat and nostrils, at the same time producing a peculiar, wheezy sound. The bird lives, as a rule, for from 2 to 5 days, occasionally 6 or 7. In the very acute form of the disease the bird may be apparently in good condition in the morning and be found dead in the afternoon.

Post-mortem appearance.—On post-mortem examination of acute cases lesions may be entirely lacking. In the less acute cases—that is, in those that live for 3 or 4 days—there is a mucous exudate in the nostrils, larynx, and windpipe, with bloodstained patches and sometimes blood clots in the windpipe. The lungs are usually more or less pneumonic. A hemorrhagic or bloodshot condition is found on the crop and under the skin in various other parts, sometimes accompanied with a gelatinous substance. Hemorrhagic spots on the muscle and sac of the heart, on the gizzard fat, on the outer surface of the small intestines, and especially on the inner lining of the two stomachs, the glandular stomach and the muscular stomach, or gizzard, are typical of fowl pest. These little hemorrhagic patches may be found along the entire intestinal canal, with considerable catarrhal condition, and when that is marked the bird has a profuse diarrhea, but the latter is not always present. A serous fluid is sometimes seen in the heart sac, or in other cases in the body cavity.

Control measures.—As the disease is incurable, control measures should be essentially the same as those recommended under the discussion of cholera. In addition, all infected shipping and receiving centers, fattening plants, chicken crates, and live-poultry cars should be thoroughly cleaned and disinfected under official supervision.

DISEASES CAUSED BY FUNGI (MOLDS)

ASPERGILLOSIS

Aspergillosis is a fungous disease of the lungs and air sacs which may affect any of the domestic birds and is quite prevalent in birds

confined in zoos or other aviaries. It is regarded as one of the causes of brooder pneumonia in baby chicks. •

Cause.—The causative agents are the common green mold, *Aspergillus fumigatus*, and the black mold, *A. niger*, which grow on vegetables and other kinds of matter. Warmth and moisture favor their development. When moldy hay, straw, or chaff is given to the fowls to scratch in, or moldy grain is fed, the spores of the fungi are inhaled by the birds.

Symptoms.—This disease may be limited to a single bird, or it may assume the form of an extensive outbreak among adult fowls. Occasionally, it may cause a brooder pneumonia among chicks, but this should not be confused with brooder pneumonia due to pullorum disease. When the air tubes or lungs are attacked, the first symptom is a slight catarrh, with accelerated breathing. Soon the swellings obstruct the passage of air and there is a rattling or croupy sound, heard chiefly during expiration. The affected birds mope, separate themselves from the remainder of the flock, or remain in a sitting posture; if made to move, they appear weak and scarcely able to walk, and if they try to run they soon fall from exhaustion. The difficulty of breathing increases rapidly; they gasp for breath and make movements of the head and neck as if choking; there are fever, diarrhea, drooping wings, great depression, a tendency to sleep, and finally suffocation and death.

When the disease is limited to the large air sacs the only symptoms are weakness and progressive loss of flesh. If the small air sacs of the bones are involved there may be lameness, with swollen and inflamed joints. The symptoms in brooder chicks are similar to those of pullorum disease. Aspergillosis is always fatal. Young chicks die within a few days. Older birds may live from 1 to 4 or more weeks after the appearance of symptoms.

Post-mortem appearance.—The walls of the windpipe, air passages in the lungs, and air sacs in the body cavity show whitish or yellowish nodules in the early stages of the disease. Later the walls are covered by elevated, dirty-yellow, or greenish layers, which represent growths of the mold, and the air sacs may become completely filled with firm yellow pus.

Prevention.—The disease is prevented by giving only clean and bright straw or chaff for the fowls and brooder chicks to scratch in, by keeping the houses and yards clean, and seeing that all grain and meal fed are sound and entirely free from mold. The sick birds should be removed from the flock, and the bodies of those which die should be burned or buried.

THRUSH

Thrush is an infectious disease of the mouth and crop, and sometimes of the esophagus and glandular stomach, of young chickens, pigeons, turkeys, and geese. The disease is caused by the fungus, *Oidium (Saccharomyces) albicans*, and is manifested by the formation of grayish-white or yellowish patches on the mucous membranes of the parts named. These patches may eventually enlarge and coalesce. A slimy discharge may drool from the mouth of the affected bird. Loss of appetite and consequent weakness and emaciation attend the disease.

Treatment.—The sick birds should be isolated. The visible thrush deposits in the mouth and throat cavities should be removed with forceps, and the erosions painted with glycerin-iodine solution (tincture of iodine, 1 part; glycerin, 4 parts). If the crop is affected it may be flushed out with a 2-percent boric acid solution. The quarters and equipment should be cleansed and disinfected.

FAVUS (WHITE COMB)

Favus of fowls is a contagious disease that begins with the formation of grayish-white spots on the comb, ear lobes, or wattles.

Cause.—This disease is caused by a fungus called *Lophophyton gallinarum* and is transmitted from fowl to fowl by simple contact.

Symptoms.—Favus generally begins in the bare parts of the head as small, white, or grayish spots, which increase in number and size until the whole surface is covered with dry, scaly, dirty-white crusts with an irregular surface. As the disease advances the neck and body are gradually invaded, and the feathers become brittle and break off, leaving a deep depression in the center of a cup-shaped disk. The disease when limited to the comb and wattles may disappear without treatment, but after it has invaded the feathered parts it almost invariably continues to advance, and the birds grow weaker until they die.

Treatment.—When only the bare parts of the head are affected, the disease may be cured by applying tincture of iodine to the diseased spots. An ointment of calomel 1 part and petrolatum 8 parts may be applied daily. It is essential to separate the affected bird from the flock. If the feathered parts of the body are affected, it is advisable to kill the bird.

DISEASES OF UNKNOWN CAUSE

INFECTIOUS RHINITIS OF CHICKENS AND PHEASANTS

Infectious rhinitis is an infectious and contagious disease which spreads rapidly through poultry flocks, attended by variable mortality. Pheasants are also affected. The disease is caused by an infective agent the nature of which is not known.

Symptoms.—The principal symptoms seen are those of a bloody or mucous exudate in the nasal passages and sinuses with or without mouth breathing. The membranes about the eyes may be swollen and inflamed, with a foamy tear formation of the affected eye. This tends to dry and stick the eyelids together. Some cases manifest a generalized edema of the region of the head and neck. There is initial fever, loss of appetite, emaciation, and sometimes coma and death. Mortality, which is apparently due to some toxic principle, may be especially high in young fowls.

Prevention and control.—General sanitary measures should be observed. Irrigation of the nasal passages with solutions similar to those recommended in this bulletin for the treatment of roup has been reported to give relief.

ROUP

Roup attacks principally the eyelids, the sacs below the eye (infraorbital sinuses), the nostrils, and the windpipe (fig. 8).

Cause.—The specific cause of this disease has not yet been definitely determined. Exposure to cold, dampness, and drafts, also crowding and poor ventilation, aid in the development of roup.

Symptoms.—The first symptoms are very similar to those of an ordinary cold, but there is more fever, dullness, and prostration. The discharge from the nasal openings is at first thin and watery, but in 2 or 3 days it becomes thick and has an offensive odor. The inflammation, which begins in the nasal passages, soon extends to the eyes and to the spaces immediately below the eyeballs, causing the formation of swellings which may reach the size of a hickory nut. The resulting pressure sometimes destroys the eye, or causes permanent loss of vision. The eyelids are swollen, held closed much of the time, and may be glued together by the accumulated secretion. The closing of the eyes prevents the badly affected birds from finding food. The accumulation of mucus in the nostrils completely obstructs these passages so that the beak must be kept open to permit breathing. The obstruction of the wind-pipe and of the smaller air tubes causes difficult respiration, accompanied by loud breathing. In the severe and advanced cases the birds sit in a drowsy or semiconscious condition, unable to see or eat; their strength is rapidly exhausted, and many of them die within a week or 10 days. Some of the affected birds recover, but others remain weak and have a chronic form of the disease for months.

This disease is distinguished from diphtheria (chicken pox) by the absence of the thick, tough, and very adherent cheesy exudates in the mouth and throat which are characteristic of the latter disease. Sometimes there may be a deposit of yellowish material on the walls of the mouth and throat, but it is easily broken up and removed. There are no warts on the comb, face, or wattles.

If mouth breathing is long continued, it eventually brings about a horny, dried condition of the tip of the tongue, commonly referred to as "pip", unless that is prevented by anointing the tongue with petrolatum or a bland oil.

Treatment.—The sick birds should be removed from the flock and put in a warm, dry, well-ventilated room free from drafts. The affected mucous membranes of the nostrils and mouth should then be treated with antiseptic solutions. The best method is to use a good spraying apparatus, but a small syringe, an oil can, or even a medicine dropper will serve the purpose. Another method is to plunge the bird's head into a basin or bowl of the solution and hold it there a few seconds, but not long enough to cause suffocation.

The antiseptics most suitable for such treatment are: Boric acid 1 ounce, water 1 quart; or permanganate of potash 2 drams, water 1 pint; or peroxide of hydrogen 1 ounce, water 3 ounces. When the

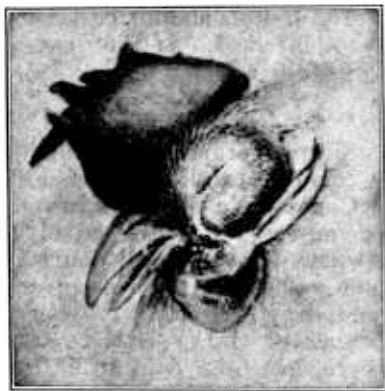


FIGURE 8.—Head of fowl affected with roup, showing swelling of the eye.

inflammation has progressed to the eye, excellent results have followed the use of argyrol, 1 or 2 drops of a 15-percent solution being placed between the eyelids twice daily for several days.

Before applying any of these substances it is well to wash the eyes and mouth with warm water containing 1 teaspoon of common salt to a quart, using a pledget of absorbent cotton and rubbing gently, at the same time pressing and massaging about the nostrils and under the eyes to loosen the accumulated secretion. If there is a swelling under the eye, it should be carefully opened with a sharp, clean knife, all the excretion removed, and the cavity washed with one of the above-mentioned solutions. A pledget of cotton moistened with the solution may be left in the opening for an hour or two.

Various types of germs have been observed as secondary invaders in the eye exudates of roup. Bacterins prepared from strains of *Staphylococcus aureus* recovered from birds affected with roup have been used with good results in the control of this disease.

The houses should be kept clean and dry and occasionally should be disinfected. If the disease is of a severe type, it is often better to kill the affected birds.

COLDS (SIMPLE CATARRH)

Simple catarrh is a mild inflammation of the nasal passages, and is common to all kinds of domesticated birds.

Cause.—No definite cause can be assigned to this affection. Weak or improperly nourished birds are more likely to be attacked than strong, vigorous, well-nourished individuals. Exposure to unfavorable conditions such as crowding, poor ventilation, dampness, and cold drafts, tending to lessen the resistance of the mucuous membranes of the nostrils to the various organisms normally present there, has been held to be the primary contributing cause.

Symptoms.—The affected bird is more or less dull in appearance, the appetite is diminished, breathing becomes difficult, and a watery discharge from one or both nostrils is early in evidence. This discharge may disappear in from 2 to 4 days, or it may take on a viscid consistency, closing the nasal openings and necessitating breathing through the mouth.

Treatment.—As the disease is of short duration, it is usually necessary only to place the bird under more favorable conditions to bring about recovery. In the more severe cases the nostrils should be washed out twice daily with boric acid in 4-percent solution, or with permanganate of potash, 1 dram (about a teaspoon) to a pint of water.

PARALYSIS (RANGE PARALYSIS, LYMPHOMATOSIS, LEUCOSIS)

The paralysis here described is a distinct disease, and must not be confused with the various types of paralysis, leg weakness, or lameness due to a deficiency of vitamins, infectious diseases, or parasites.

Birds may be affected between the ages of 6 weeks and a year or more, but the highest incidence of the disease occurs between the ages of 4 to 8 months. The mortality may be very high, in some cases reaching 50 percent or more of the flock.

Cause.—The cause has not been definitely determined. There is some evidence indicating that it may be due to a filtrable virus, with possible transmission through the egg.

Symptoms.—There are several manifestations of this disease which may occur separately or in combination. These are: The nerve type—paralysis of the limbs due to inflamed nerves, and the eye type—iritis, or gray eye due to infiltration of the iris.

The following related diseases are also thought by some investigators to be due to the same virus: Leukemia ("big-liver disease"), and the anemias (erythroleucosis).

Perhaps the most common and most striking type is that in which the nerve supply to the legs or wings is affected, causing lameness, or drooping of the wing or wings. The onset may be sudden, the first noticeable symptom being a slight limp or incoordination when the bird runs. In acute cases this lameness may become rapidly worse so that the bird becomes prostrated in a day or two. The paralysis of the legs is usually not complete, and the bird although unable to stand may still be able to kick when disturbed. A characteristic posture is one in which the bird lies on the breast with one leg extended forward and one backward. Either one or both legs or one or both wings may be affected.

Occasionally the brain may be involved, causing a twisting of the neck. In some cases the bird may fall forward as if turning somersaults.



FIGURE 9.—Carcass of fowl which died of paralysis. The nerves that supply the wings and legs are greatly enlarged. *aa*, Nerves to wings; *bb*, nerves to legs.

In the iritis type there may be no outstanding symptoms or lesions other than emaciation and a progressive discoloration of the eye, ranging from a narrow gray ring around the margin of the pupil to total grayness of the iris. The inner margin of the iris may become irregular and the pupil contracted to a small size so that blindness is produced.

In all types of the disease the appetite remains good, but emaciation usually occurs. Acute attacks may terminate fatally in a few days, whereas birds affected with the chronic form of the disease may live for weeks or months, and a few make an apparent recovery.

Post-mortem appearance.—On autopsy of the paralyzed cases it will be noticed that the nerve supplying the affected limb is swollen (fig. 9). The part of the nerve in which the swelling is most prominent is generally the first half inch or so after emergence from the spinal column, though sometimes the swelling is apparent all the way down the leg or wing to the nerve ending. It is sometimes necessary to remove the kidney to observe the enlargement of the nerve plexus.

In the several types of this disease, extreme emaciation and atrophy of the internal organs will usually be noted, except in leukemia ("big-liver disease") in which there may be enormous enlargement of the liver, spleen, and kidneys, together with localized or diffused gray discoloration. In some cases the ovary becomes tumorous, and may be enlarged to the size of an egg. The muscles are usually dark red, and capillary hemorrhages may be seen.

Mode of transmission.—There is considerable evidence that this disease is transmitted through the egg. It is also thought by some investigators that it may be transmitted by contact of healthy birds with infected birds or with contaminated surroundings.

Control.—Until more is known of the cause and mode of transmission of the disease only general control measures can be suggested. It would be advisable to dispose of all birds showing symptoms of the disease, and to thoroughly cleanse and disinfect the premises and utensils. New stock, including baby chicks, should be selected from sources known to be free from this disease and should be maintained apart from the original flock in which the disease occurred.

DISEASES OF THE DIGESTIVE ORGANS

IMPACTED CROP (CROP-BOUND)

The affection known as impacted crop or crop-bound is an over-distended and paralyzed condition of the crop, generally caused by overeating or by swallowing coarse and indigestible substances, such as feathers, or fibrous feeds, especially straw. In fowl cholera and some other diseases, the crop is paralyzed as a result of the disease.

Symptoms.—The first symptom is a loss of appetite, or an effort of the bird to swallow without being able to do so. The crop is very large and much distended, with contents more or less firmly packed together. If permitted to continue, the condition becomes aggravated, breathing is difficult, and death may result.

Treatment.—The contents of the crop may be removed sometimes by forcing the bird to swallow a teaspoon or more of sweet oil and

massaging the lower part of the gullet, if it contains feed, or if not, the part of the crop nearest to the gullet, until the contents are softened and may be pressed toward the head. This is made easier by holding the bird head downward. By continued manipulation the greater part of the material may be removed. The bird should not be permitted to eat for several hours after it is relieved. If this treatment is not successful, the crop may be opened with a sharp knife and the contents removed through the opening, a coffee spoon, a button-hook, small forceps, a bent wire, or other suitable instrument being used for this purpose. Then wash out the crop with clean, warm water. The opening should not be more than an inch in length and should be closed with 3 or 4 stitches, first in the wall of the crop and, when this is finished, by an equal number in the skin. Each stitch should be made and tied separately. Coarse, white silk is the best material, but if it is not available ordinary cotton thread may be used. Feed for a day or two on milk and raw egg, beaten together, and gradually change to soft mash.

INFLAMMATION OF THE GLANDULAR STOMACH (PROVENTRICULITIS)

Inflammation of the glandular stomach is often seen in growing chicks reared in confinement, and occasionally in adult fowls.

It is generally due to dietary deficiency, or some debilitating disease. It is characterized by a thickening of the wall so that the glandular stomach takes on a globular shape. The lining mucous membrane usually shows various stages of inflammation, ulceration, and atrophy of the digestive enzyme-secreting glands. This glandular atrophy results in poor digestion and emaciation.

This condition can be definitely diagnosed only on autopsy, but if chicks show emaciation in the absence of any other apparent cause, proventriculitis should be considered.

INFLAMMATION OF THE INTESTINES (ENTERITIS)

Enteritis is an inflammation of the lining (mucous) membrane of the intestines. It is not a distinct disease but results from some other condition such as malnutrition, infectious diseases, or the presence of internal parasites.

This inflammation may vary in degree from a mild catarrh in which there is an excess of mucus and pus in the intestine to a severe hemorrhagic type in which there is capillary hemorrhage into the lumen and the intestinal contents are bloodstained. In severe chronic cases ulcers or erosions of the mucous membrane may develop so that digestion and assimilation of food are seriously interfered with and poisons are absorbed into the circulation. In other cases irritating substances in the diet may cause diarrhea.

Treatment.—This consists in diagnosing and treating the condition that caused the inflammation. If malnutrition is the cause, the diet should be balanced with proper feed which should contain adequate amounts of the vitamins. All injurious and irritating substances such as sand, straw, or shavings should be removed when there is a tendency to depraved appetite. If parasites are the cause of the inflammation, measures should be taken to eliminate them. In most cases of enteritis medication is not advisable.

WHITE DIARRHEA OF CHICKS

White diarrhea is a commonly used term which covers various diseases of chicks from the time of hatching until the birds are approximately 1 month old. It merely indicates a common symptom, a whitish diarrhea, which is usually observed in sick chicks, no matter what the specific nature of the disease may be.

Cause.—Aside from specific infections which are discussed elsewhere in this bulletin, the principal cause of white diarrhea is a nonspecific fever accompanying colds, chilling, overheating, or intestinal disturbance from incorrect feeding or insanitary quarters.

Symptoms.—The disease may run a mild and transitory course, or it may progress in severity with aggravated symptoms approaching those of pullorum disease, which is described elsewhere in this bulletin.

Treatment.—Medical treatment of affected chicks is impractical. Corrective treatment consists in practical measures to remove the cause or causes indicated, and in general to secure, for the brood, clean and comfortable living conditions, including proper feeding, watering, and ventilation.

INDIGESTION

To digestive disturbance may be attributed numerous conditions, such as loss of appetite, pica (abnormal or depraved appetite), sour or hanging crop, impaction of the gizzard, diarrhea, or constipation.

Cause.—The principal causes are irregularities of feeding, such as feed that is too coarse, dry, or fibrous; moldy or decayed feed; access to poisonous plants or irritating chemicals; lack of grit in the gizzard; or polluted water supply.

Indigestion may also occur as a symptom of some diseases, such as catarrh of the crop or stomach, enteritis, or parasitism, in which cases special treatments should be given.

Treatment.—The ration should be clean, wholesome, nutritious, and easily digestible, supplemented by a constant supply of grit, charcoal, and crushed oyster shell. For impaction of the gizzard or constipation, Epsom salt, 1 pound to each 10 quarts of drinking water, may be placed before the flock for 1 day instead of other drinking water; or castor oil, 1 pint per hundred birds, may be fed thoroughly mixed in a moist mash.

Sour or hanging crop may be treated by flushing out the crop with a bicarbonate of soda solution, consisting of 2 teaspoons of the soda to a pint of warm water, in a fountain syringe. Hold the head of the bird down, and empty the crop by gentle pressure, repeating the process daily until the bird recovers. Keep the bird on a soft diet, principally sour milk or buttermilk, for several days after recovery takes place. Following attacks of indigestion it is sometimes beneficial to stimulate the appetite and promote the secretion of digestive fluids by the administration of a tonic. A veterinarian can best prescribe the tonic most suitable in a particular case.

DISEASES OF THE REPRODUCTIVE ORGANS

INFLAMMATION OF THE EGG DUCT (SALPINGITIS)

Inflammation of the egg duct is characterized by a whitish diarrhea and a creamy discharge from the egg duct which soil the

feathers around the vent and cause redness and irritation of the skin. Other birds attack the affected individual, severely lacerating the posterior parts and in a short time disemboweling the victim.

The sporadic occurrence of bloody eggs, stinking eggs, misshapen eggs, yolkless eggs, eggs with blood-smeared shells, soft-shelled eggs, egg-bound, etc., may at times be traceable to isolated cases of salpingitis and may even be the forerunner of a general outbreak of the disease. Some outbreaks of salpingitis are traceable to infection with *Salmonella pullorum*. Many cases of peritonitis caused by the internal rupture of infected egg yolks may be variations of this disease.

Treatment.—When only a few birds are affected, relief may be afforded by douching the egg duct with a one half of 1-percent solution of creolin. Segregation of the visibly affected birds, thus protecting them from attack by others, should increase the number of recoveries. Male birds should be kept away, as they may spread the infection to healthy hens through breeding activity. This condition often occurs, however, even in virgin pullets, without reference to the activities of the male, and differs in this respect from vent gleet.

In outbreaks of salpingitis which may be traced to *Salmonella pullorum* infection it would be unwise to use for breeding purposes any birds which had been affected, as to do so may cause the spread of pullorum disease in the chicks.

EGG-BOUND

The condition known as egg-bound (failure to pass the egg in the normal manner) is of frequent occurrence in fowls, especially in pullets beginning to lay.

Cause.—The difficulty may be due to inflammation, stricture, or tumor formation in the posterior part of the egg passage. Sometimes malformed or double-yolked eggs are responsible. In pullets the usual cause is the attempted passage of a large-sized egg before the egg passage has become sufficiently dilated to accommodate it.

Symptoms.—Affected hens become restless and make frequent visits to the nest in their effort to lay. The straining may cause inflammation and often eversion of the oviduct (egg tube) through the vent. Others of the flock, attracted by the inflamed, protruding parts, peck at them and tear out portions of the egg passage and intestine, causing the death of the hen. If prolapse does not occur, the distressed fowl may continue her efforts to lay until successful or until overcome by weakness or internal hemorrhage from rupture of the oviduct. The egg may be felt by passing the forefinger through the vent.

Treatment.—The surest method of treatment is to remove the egg by the following procedure: Pass the forefinger through the vent. With the other hand pressing on the abdomen of the fowl force the egg toward the vent, guiding it by the aid of the inserted finger. When the shell is observed through the vent, puncture it with an awl or other sharp-pointed instrument, break it in pieces, and withdraw these and the egg contents. Isolate the bird and inject cold water into the cloaca (the common passage into which the intestine and the oviduct open) to reduce the inflammation. If the oviduct

has been everted through the vent, clean and push the parts back and inject cold water frequently until the tissues remain in place.

VENT GLEET (CLOACITIS)

Vent gleet is an infectious, venereal disease of fowls which is spread by the rooster in treading. Its causative agent is not known.

Symptoms.—There is inflammation of the cloaca and vent. The skin around the vent is swollen, reddened, and ulcerated, and an offensive odor is usually present. The droppings are foul smelling and liquid and are frequently voided. Other chickens may peck at the inflamed part and often tear the cloaca and rectum, causing the death of the victim.

Treatment.—The disease is very resistant to treatment. It is usually better to destroy the bird. If treatment is desired, 3-percent silver nitrate solution may be applied to the mucous membranes of the cloaca by means of a cotton swab, or 2-percent carbolic ointment may be applied daily over the affected area.

MISCELLANEOUS DISEASES AND CONDITIONS

TUMORS

A number of varieties of tumors occur frequently in birds. The largest percentage is found in fowls more than 2 years old. In hens the egg organs are affected in more than 50 percent of the cases. Tumors in birds have a marked tendency to break down and cause death from internal hemorrhage. Tumors on the skin are easily recognized while internal ones may be suspected when an individual in the flock shows poor condition, increasing droopiness, or emaciation.

Treatment.—There is no treatment for internal tumors. External ones can be removed satisfactorily in some cases by surgical means. Since many of the growths, however, are of a malignant or cancerous nature, it is best to kill the bird and destroy the carcass.

LAMENESS IN GEESE AND DUCKS

Young geese and ducks are affected with an inflammatory condition of the joints of the feet and wings associated with an internal infectious disease.

Cause.—The disease is caused by a microorganism known as *Staphylococcus aureus*, which multiplies in the internal organs and in the bones and joints.

Symptoms.—The disease may be acute, causing death in from 2 to 4 days, or chronic, with symptoms continuing for more than 2 weeks, when death may occur or gradual recovery take place. In acute cases there is general depression, diarrhea, and discharge from the eyes. In chronic cases the general symptoms are less marked, but emaciation is pronounced. The characteristic symptoms in both cases are lameness and the swelling of the joints of the legs or feet. Usually only one leg will show lameness, and the hock joint or one of the toe joints is most often affected. The swellings are hot and painful. The bird frequently lies on its breast with legs extended

backward and, if forced, can move only short distances by flapping the wings. Sometimes the wing joints are swollen and the wings droop.

Post-mortem appearance.—The intestine is inflamed and its contents are slimy and reddish in color. The liver and spleen are enlarged. The diseased joints are reddened, swollen with fluid, and contain yellowish, fibrous, or cheesy exudates.

Treatment.—Acute cases do not respond favorably to treatment. The joints should be painted daily with tincture of iodine. Separate the sick from the well and keep the houses and utensils clean and disinfected. Keep the ducks and geese from stagnant water, and when giving drinking water dissolve one third teaspoon of permanganate of potash in each gallon.

WING LAMENESS IN PIGEONS

Pigeons have swollen and disabled wing joints as a result of tuberculosis, gout, or mechanical injuries. They also are affected with a disease which is caused by an infectious organism resembling somewhat the causative agent of tuberculosis. This germ grows underneath the skin and induces the formation, on the head, neck, or wings, of lumps of yellowish, cheesy material which enlarge to the size of a marble. When these lumps are present in the wing, especially near a joint, flight may be impaired or made impossible.

Treatment.—Lance the skin over the growth, press out the ball of cheesy matter, and paint the cavity with tincture of iodine daily for several days.

BUMBLEFOOT

Bumblefoot is a term applied to a swelling of the foot in fowls. It may result from bruises, as in the case of heavy birds jumping from high perches to hard surfaces, or it may be due to cuts or punctures of the skin of the foot which becomes infected by germs. These organisms set up an inflammation with the formation of fluid or cheesy, suppurative material, usually in the ball of the foot.

Treatment.—In some cases the application of tincture of iodine to the swollen area daily for several days will bring about recovery. If the swelling is hot and has the appearance of an abscess, it should be lanced and the contents washed out. The interior of the abscess is then soaked with 5-percent carbolic acid or tincture of iodine and the foot bandaged. The fowl should be placed in a small compartment without a perch and the wound disinfected daily for several days.

SUBCUTANEOUS EMPHYSEMA (AIR UNDER THE SKIN)

Subcutaneous emphysema is a condition in which the skin of the breast and other parts of the body is distended by air, and thus separated from the underlying tissues of the bird's body. This gives the bird a peculiar puffed-up appearance. The inflated condition of the skin is immediately detected by handling the bird. Chickens, pigeons, and turkeys are susceptible to the condition.

Cause.—It is probable that subcutaneous emphysema is ordinarily caused by a rupture of one of the air sacs of the body, or other respiratory organs, which permits a leakage of inhaled air into the spaces immediately beneath the skin.

Treatment.—No medicinal treatment for the condition is known. Relief may be afforded by slitting the skin over affected areas, thus allowing the accumulated air to escape. Some cases may be reduced by exerting prolonged gentle pressure over the distended portions of the body of the bird, and in this way forcing some of the air out through the same avenue by which it gained entrance into the subcutaneous region.

FEATHER PULLING

Feather pulling is a vice which may originate from several causes, such as close confinement, idleness, lack of sufficient mineral or animal matter in the feed, or the presence of itch mites at the base of the feathers. (See Depluming Scabies.) A particularly vicious hen may begin the practice, which may be imitated by others of the flock and continued as a habit.

Treatment.—Allow as much room as possible for exercise. Scratching for feed in deep litter helps to keep the birds busy. Provide a variety of feeds with meat scrap and plenty of green feed and crushed oyster shell. The early discovery and isolation of the principal offenders will frequently check the trouble where it is merely a habit and not due to other causes. If mites are present, treat as for depluming scabies.

Feather pulling and cannibalism may be prevented by cutting off the tip of the upper beak about three sixteenths of an inch from the point.

CANNIBALISM

Toe pecking is observed in young chicks, especially those confined in brooders. Chicks peck at feed stuck to the foot and thus wound the skin. The taste of blood causes them to continue pecking at the toes of the victim and to attack other chicks. They may also peck at the vent and disembowel the chick in a short time.

Treatment.—Remove all wounded chicks as soon as they are observed and isolate them until recovery is complete. Keep the others occupied by hanging vegetables or bones with shreds of meat attached at a height which will cause them to jump in reaching them. It may be advisable to confine the flock in a partially darkened place for a while. Painting the windows with transparent red paint, or providing illumination solely through red electric bulbs to disguise the color of blood, has been found to aid in checking cannibalism among either young or adult birds.

LIMBER NECK (BOTULISM)

The condition known as limber neck is a symptom of several diseases, among which are botulism or other food poisoning. It is characterized by a paralysis of the muscles of the neck, which makes it impossible for the bird to raise its head from the ground. This condition is due to the absorption from the crop or intestines of poisons which act on the nervous system and cause paralysis. It is

generally associated with the eating of spoiled feed or putrid meat in which certain poison-producing organisms are growing, or of fly maggots which have bred on such material.

Treatment.—The best treatment is to give a full dose of purgative medicine—that is, one half teaspoon of Epsom salt, or 3 or 4 teaspoons of castor oil for a grown fowl. Unless treatment can be given very promptly there is little hope of saving the bird. Spoiled canned goods should not be fed to chickens. Carcasses of fowls or other animals should be burned or deeply buried as soon as found.

ROSE-CHAFER POISONING

Rose chafers, or rose beetles, are extremely poisonous to chickens under 10 weeks old. They are found in the Atlantic Coast, Middle West, and Central States. When these beetles are on vegetation chickens devour them readily, and only a few are necessary to cause death.

Symptoms.—Signs of poisoning may appear as early as 1 hour after feeding on the chafers, and death may follow in 1 hour after the appearance of symptoms. If sufficient poison is not absorbed to cause death, the bird recovers. The affected chicken becomes drowsy, shows weakness of the legs, and falls over on its side. There may be convulsions. Sharp cries are frequently emitted, and the head and neck are retracted over the back of the bird. The only evidence of the disease is the presence of rose chafers in the crop.

Treatment.—The rapid action of the poison renders treatment futile in birds showing symptoms. When the nature of the trouble is realized, other birds in the flock which had opportunity to eat chafers should be given Epsom salt in the proportion of one fourth teaspoon, mixed with a small quantity of feed, to each bird. Preventive measures consist in keeping young chickens in enclosed runs or at points where they will not have access to grapevines, rose-bushes, and shrubbery when the insects are prevalent. This corresponds somewhat closely to the time of first blossoming of the various garden flowers. Destruction of the beetles should be practiced by spraying infested plants with one half or three fifths of a pound of lead arsenate to 10 gallons of water.

SALT POISONING

Chickens, turkeys, and pigeons are susceptible to poisoning by common salt. Care should be taken not to leave fish brine, freezing brine, or ice-cream salt within reach of the fowls, as they may swallow sufficient quantities of the material to poison them.

This form of poisoning is manifested by progressive paralysislike symptoms accompanied by extreme drowsiness, and finally death by asphyxiation due to the weakening effect of the poison upon the muscles of respiration. In poultry there is no practical treatment for salt poisoning.

PARASITES AND PARASITIC DISEASES

A number of different kinds of parasites found in poultry in the United States may seriously affect the health of the birds. These

parasites may be divided into three general groups. One group, known as Protozoa, consists of organisms so small that they can be seen only with the aid of a microscope. The second group consists of worm parasites, of several kinds, all but a few of which are sufficiently large, when full-grown, to be seen with the naked eye. The third group is made up of small, parasitic arthropods, namely, cer-

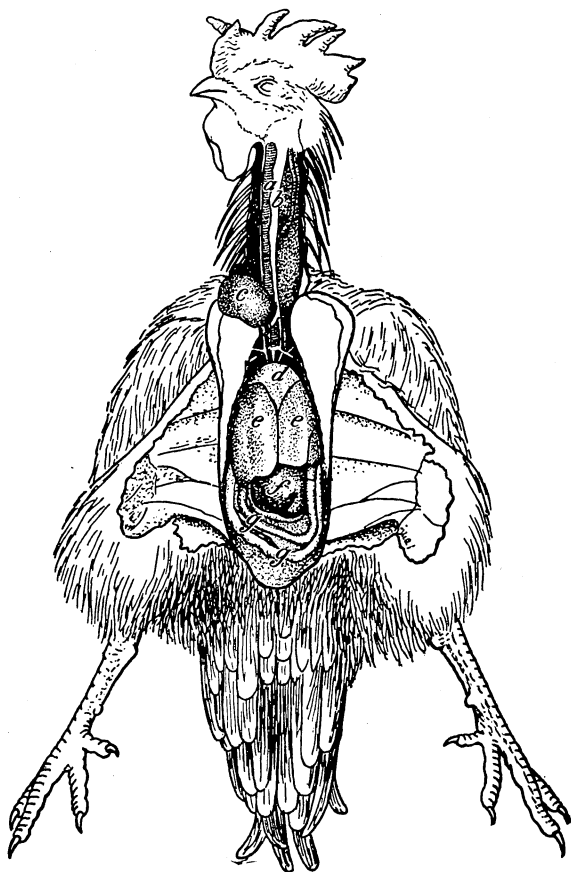


FIGURE 10.—Appearance of internal organs when fowl first is opened up. See figure 11 for explanation of letters. Adapted from Sunderville, 1928.

tain insects (including lice and fleas), and certain mites, which include not only mites as commonly known but also ticks. The location of parasites varies greatly with the different kind of parasites; Protozoa may occur in the blood stream, in the kidneys, and in the intestines of certain domestic birds; worm parasites may occur in such varied locations as the eye, the windpipe, all parts of the digestive tract, the reproductive organs, and in or under the skin; and arthropod parasites of poultry occur chiefly on the outside of the body, either on the feathers or in or under the skin, but, on the other hand, in the case of certain mites, may occur within the body, in the air passages, lungs, and liver.

METHOD OF EXAMINING FOWLS FOR PARASITES

An examination of a domestic bird, for the purpose of determining whether parasites are present, must take into consideration these differences in the kinds of parasites and their possible locations. As regards the internal parasites, for locating Protozoa, smears or sections made from infected parts of the bird must be examined microscopically. On the other hand, to locate worm parasites and the mites which occur within the body, the various parts of the body may be examined according to some such procedure as the following:

In examining a dead fowl the feathers are removed from the under side, the abdomen is carefully opened along the median line, and the breast is cut loose on each side and turned forward, as in figure 10. The various internal organs are then carefully loosened from the tissues which hold them in place, and, after being spread out, as in figure 11,

so that they can be separated and identified, they are removed from the bird. The windpipe or trachea (*a*) is cut open and its inner surface examined; the lungs (*k*) are also removed and carefully inspected. The esophagus, including the undilated part and the crop (*b* and *c*), is slit open and the contents washed into a shallow glass dish and examined; the wall of the esophagus is examined by stretching it between the hands and holding it up between the observer's eyes and the light so that the light shines through it and thus throws into relief the outline of any worms embedded in the wall. The remainder of the digestive tract, made up of the two stomachs, namely, the glandular stomach (*h*) and the muscular

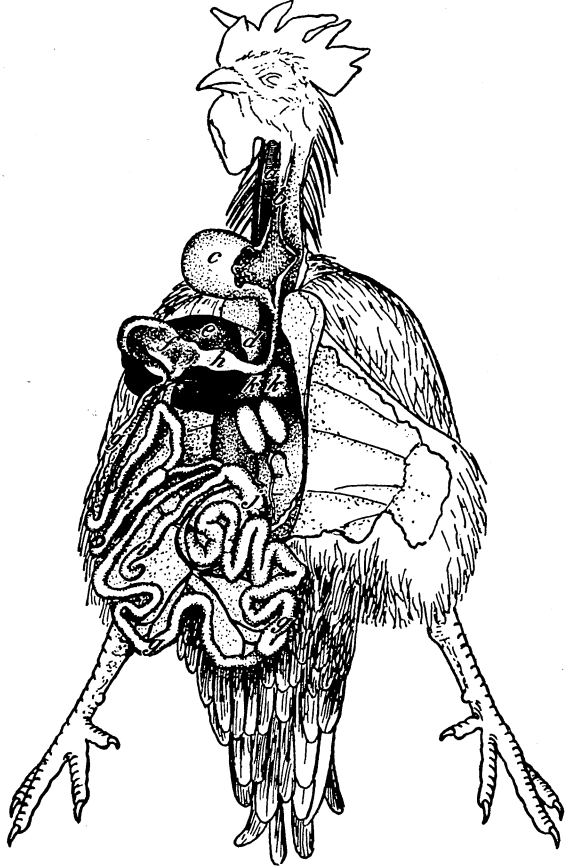


FIGURE 11.—Internal organs of fowl, which have been spread out: *a*, Windpipe or trachea; *b*, undilated esophagus; *c*, crop; *d*, heart; *e*, liver; *f*, gizzard; *g*, intestines; *h*, glandular stomach; *i*, ceca or blind guts; *j*, rectum; *k*, lungs. Adapted from Sunderville, 1928.

stomach or gizzard (*f*) and the intestines (*g*), is next cut loose and lifted out into a dish of water. The glandular stomach or proventriculus (*h*) is opened and washed into a glass dish, and the glands are squeezed so that embedded parasites may be loosened; the wall is examined on both the inner and outer surfaces, one of the nematodes found in this location, namely, the globular, red tetramere, often showing more clearly through the semitransparent outer surface than through the opaque inner surface. The muscular stomach or gizzard (*f*) is opened, and its contents are emptied out and examined; the horny lining is then peeled off, and the under surface of the lining and also the newly exposed surface of the muscular wall are examined for parasites. The small

intestine (*g*) and finally the ceca (*i*) are slit open in water, separately; the wall of these organs is run through between the thumb and fingers and examined carefully during the process, in order to remove any parasites which are buried in the mucus or attached to the wall; the intestinal contents may be washed and allowed to settle several times until the water is clear, and then examined in shallow glass dishes.

METHOD OF KILLING AND PRESERVING PARASITES

Protozoa can be found to best advantage in fresh material, and in the case of certain organisms belonging to this group they can be found only in such material. In other cases, as the coccidia, if microscopical examination cannot be made on the intestinal contents when they are fresh, such material may be satisfactory for examination if preserved by the addition of formaldehyde solution. Worm parasites which have been collected should be well washed in water in order to remove all mucus or other clinging material, and should then be put into a weak solution of formaldehyde (from 2 to 4 percent), which has been warmed to the point at which it begins to steam. Material of this sort can be shipped to laboratories for identification. Arthropod parasites may be preserved in 2-percent formaldehyde solution or 75-percent alcohol.

VARIOUS METHODS OF REPRODUCTION AND OF SPREAD OF PARASITES

The different kinds of parasites of poultry have very different life habits. A knowledge of these habits is important in understanding the diseases caused by them and in deciding on methods of checking those diseases. Protozoa, for instance, multiply within the bird's body so that one organism may give rise to large numbers of organisms (fig. 15, A). Worm parasites, on the other hand, do not multiply within the bird's body; a single egg or single young parasite which gains entrance into the body develops into only one worm, and multiplication depends on the eggs or young worms produced by such a parasite; the parasite eggs or young worms must pass out of the body and undergo more or less development on the ground or in such lower animals as insects before giving rise to additional parasites in birds.

The development of the various stages outside the bird's body differs greatly in different worm parasites. In some cases there is a direct life history; the parasite eggs which pass out of the body develop within them the young stage of the worm which on being taken into the body of a bird will infect it and will develop to an adult parasite. In other cases the life history is indirect; the bird is known as the primary host, and the parasite eggs which pass out of its body must go into one or more intermediate hosts before again going back to a bird. An example of such an indirect life history is given subsequently with reference to one of the flukes found in birds. In the cases of indirect life histories of tapeworms and roundworms, only one intermediate host is necessary, so far as is known; the nature of the intermediate host may vary and is still unknown for some parasites, but in certain instances insects, snails, slugs, and earthworms have been found to serve in this capacity. Figure 12 gives in diagrammatic form the various steps in such a life history.

GENERAL MEASURES FOR THE CONTROL OF PARASITES OF POULTRY

Poultry houses and yards should be so placed that rain water will not wash from one to another. Marshy places should be drained, and holes in which water may collect should be filled in. Even if permanent quarters must be used to some extent, a rotation of yards is highly desirable; the ground should be plowed under and then planted to green stuff when the yard is not in use.

As the most severe damage from parasites occurs in young birds, special precautions should be taken to protect the young. They should be raised away from the older birds, which are often carriers of parasites, and from the infected areas occupied by them.

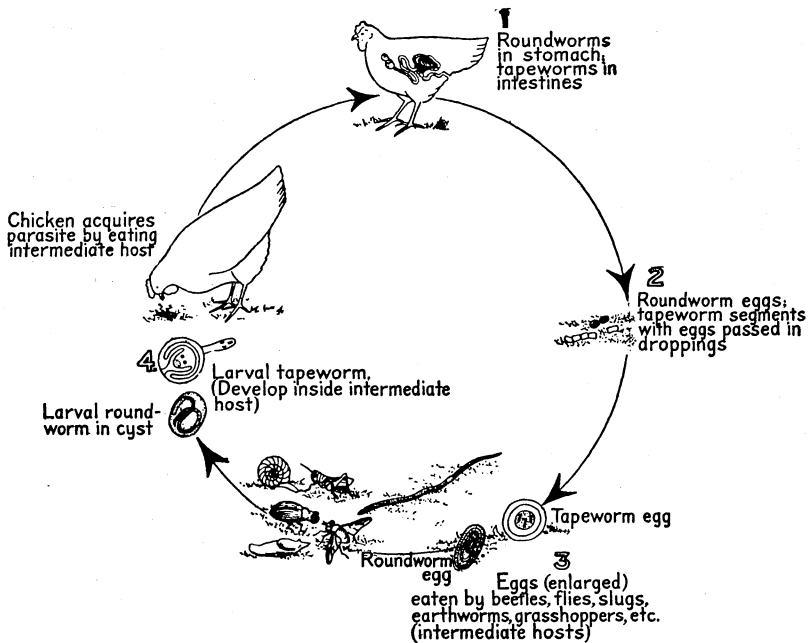


FIGURE 12.—Diagram of the various stages in an indirect life history of a tapeworm or roundworm, parasite in poultry.

As regards sanitation, feed and water should be given in containers which will not allow contamination of the contents with the birds' droppings. The frequent removal and disposal of droppings are likewise important preventive measures. Disposal should be effected by a method which will keep the droppings with their content of worm eggs and Protozoa not only from the chickens but also from the intermediate hosts of the parasites and from wild-animal life which may serve as carriers in one way or another. It is advisable to keep yards free from boards and miscellaneous objects, since they may harbor such intermediate hosts or carriers. Filling in or draining low, damp areas which may breed such intermediate hosts, and the screening of houses are also of value in this connection. A screen, to be effective, should have a mesh small enough to keep out even such small insects as the smaller dung beetles.

The practice of using chicken manure as fertilizer is dangerous from a poultry standpoint, if the manure is spread in places where chickens will have access to it or in places where small animal forms may feed on it and may serve as intermediate hosts or as mechanical carriers to convey parasites back to the poultry. The danger is lessened if the chicken manure is stored in a manner that causes it to heat. The development of heat in the chicken droppings during storage tends to destroy worm eggs and other harmful organisms. Lack of oxygen also aids in this destruction.

A method for the storage of horse manure so that sufficient heat is produced to destroy worm eggs has been worked out by the Bureau of Animal Industry with very satisfactory results, and it would probably be applicable to poultry manure. A double-walled, double-floored, wooden pit, with sawdust between the double parts of the walls and floor for insulation, with a tight cover to hold the heat, was found to be the best kind of storage; all parasitic-worm eggs were destroyed in a period of 2 weeks in horse manure stored in this manner. It is a common practice to store chicken droppings in barrels. If the barrels have a tight cover and a suitable external insulation to hold the heat, droppings which are not dried by the addition of sand or similar material may be expected to heat to the point where parasitic material is destroyed.

DISEASES CAUSED BY PROTOZOA

BLACKHEAD (ENTEROHEPATITIS)

Blackhead is primarily a disease of the intestines and liver, but the fact that the head of the bird affected often becomes discolored has given it its popular name, blackhead. It is most frequently seen as a disease in turkeys, but chickens also are susceptible. The ruffed grouse and bobwhite quail likewise have been found to suffer from the disease.

Cause.—The parasite (*Histomonas meleagridis*) causing blackhead is one of the Protozoa. The organisms live part of the time free in the cavity of the ceca, or blind guts, but in another stage of the disease they burrow into the walls of the ceca and are carried through the blood stream to the liver. The organisms in the ceca multiply in large numbers and pass out in the droppings.

Spread of the disease.—Young and adult chickens may contract this disease, but although in some outbreaks they may die in considerable numbers, they more usually recover promptly. However, in spite of their recovery, they remain carriers of the parasites, which are discharged in their droppings in vast numbers, from 20,000,000 to 40,000,000 of the organisms passing daily from one chicken. These organisms may infect other birds, either chickens or turkeys, if picked up by them in contaminated feed or water. The realization that turkeys may die, in large numbers, of blackhead contracted from chickens which have the disease in so mild a form as to show no evidence of it has led to strong emphasis being placed on the recommendation that turkeys be kept away from chickens.

It is probable that the parasite which causes the blackhead was originally brought to North America in chickens from Europe and that it was passed on to turkeys in this country, thus introducing a

new disease to which turkeys were more susceptible than was the chicken, which in the course of time had become resistant to it.

Another highly important factor in the spread of blackhead disease is the part played by the common cecum worm (*Heterakis gallinae*) of chickens and turkeys. The worms in the ceca of a fowl which is infected with the blackhead organisms may carry these organisms in their bodies; the eggs of the worm, which are passed out in large numbers in the droppings of the fowl, carry these small blackhead parasites with them. When the eggs are eaten, in contaminated feed or water, by a fowl and hatch in the fowl's ceca, the blackhead organisms are transmitted to the bird and set up the disease. The protozoan parasite, being thus included within the shell of the worm egg, is protected from heat, cold, dryness, and other adverse conditions which would otherwise destroy it. The worm eggs, which are resistant to such factors because of their thick shells, can hold the blackhead organisms in the soil from one year to another, whereas it has been found that the blackhead organism itself, without such protection, seldom survives for more than 24 hours outside the body of the fowl.

Symptoms.—The disease may occur at any time in the life of a turkey, but it is most prevalent in young birds. Droopiness, loss of appetite, an invariable loss of weight, and sometimes a sulphur-colored diarrhea are the main symptoms. The discoloration of the head, which has given the disease its name, is seen also in other diseases and is not always present in this disease, so that the term "blackhead" is not a very satisfactory term. Death may occur suddenly.

Internal changes.—An examination of the turkey after death shows the ceca, or blind guts, enlarged and filled with a solid, yellowish, cheesy mass; the walls of the ceca may have areas which are roughened and thickened. In addition to the changes in the ceca, the liver is often affected; it is enlarged and often spotted with dark-red, gray, or yellow areas, which are depressed below the surface rather than raised above it (fig. 13).

Treatment.—Although many drugs have been tried and some are recommended for the treatment of blackhead, none have been found very satisfactory. The only drug known to be effective is tryparsamide, and the fact that it must be given by injections into the blood stream in a carefully measured dose, and also that it is very expensive, makes it unsatisfactory for general use. The only practical, general procedure consists in the use of control measures to prevent the development of the disease.

Prevention.—Since, as explained above, the chicken may act as a carrier of the parasite causing blackhead disease, turkeys should be kept completely removed from chickens or land ranged by chickens or fertilized with chicken manure. Although observations made on turkeys indicate that turkey hens which have previously had the disease are unlikely to remain carriers of the blackhead organisms and so infect the poults, nevertheless in actual practice the best results are obtained with artificially reared birds—that is, those hatched in incubators and brooded artificially. The poults should be kept first in coops and runs that can be easily cleaned, and later on pasture that is known not to have been ranged by chickens and preferably

not to have been used for older turkeys. The University of California has carried on cooperative projects with turkey raisers along these lines with considerable success, the losses among such artificially reared turkeys being much less than those of previous years under the old system.

The University of Nevada Extension Service recommends the tobacco-dust treatment of turkeys, when 2 months old, for cecum worms, since the worms play such an important part in spreading the parasite. Mash containing 2 percent of ground tobacco may be fed for from 1 to 3 weeks at that time. The losses from blackhead are said to have been considerably reduced in localities using this treatment. Other treatments for cecum worms are given in this bulletin (p. 57). Any turkeys which show symptoms of the disease should be promptly removed and isolated, and those which have died should be buried.



FIGURE 13.—Enterohepatitis (black-head). Liver of turkey, showing necrotic areas.

COCCIDIOSIS

Cause and nature of the disease.—For many years it was thought that minute protozoan organisms known as coccidia, found in a large variety of birds, both domestic and wild, were all the same species, *Eimeria avium*. Recent studies, however, have revealed that there are at least 6 species of coccidia in chickens alone, the diseases caused by them varying in location and intensity. One species, *E. mitis*, may live in the small intestine without producing noticeable damage to its wall and without seriously affecting the health or growth of the chicken. Another species, *E. tenella*, which is found in the blind guts, or ceca, of the chicken, affects the health of the bird very decidedly, producing the symptoms of coccidiosis as they are most widely known among poultry raisers. This is the acute form which is often seen in baby chicks during the first few weeks of life; the coccidia invade the wall of the gut and often produce extensive hemorrhages, blood being noticeable in the droppings. Other symptoms, which in fact may appear earlier than that of bloody droppings, are ruffled feathers, pallor, and rapid wasting (fig. 14). Chicks up to 2 months of age may die very suddenly and in large numbers as a result of this form of the disease.

A serious chronic form of coccidiosis may be caused by another species, *E. acervulina*; the organisms in this case live chiefly in the upper part of the small intestine, producing whitish or grayish spots in the wall. Extreme emaciation or wasting of the fowls in severe cases is the principal characteristic of this form of coccidiosis.

Another coccidium, *E. maxima*, occurs in the middle or lower part of the small intestine, producing a thickening of the wall with a variable amount of hemorrhage; however, the quantity of blood passed in the droppings is never so great in this disease as in that

involving the ceca. In severe cases of this type, pallor, roughening of the feathers, and diminished appetite result.

E. praecox and *E. necatrix* occur in the small intestine. The latter is pathogenic and produces severe hemorrhage.

Turkeys may be infected with coccidia, *E. meleagridis* and *E. meleagris*, species different from those found in chickens. Although outbreaks of coccidiosis occasionally occur in young turkeys, the disease is not yet so widespread or so severe in these birds as it is among chickens. It is probable that the young poults develop an immunity to the organisms at an early date, as turkey poults may show the presence of these coccidia within the first week after hatching, but may not appear to be injured by them.

Pigeons are also parasitized by one of the coccidia; this is probably some other species, but its identity has not yet been established. The disease produced in pigeons may be rapidly fatal or may be chronic. In geese, coccidia produce a disease of the kidneys which may weaken them so greatly that they are unable to walk; the birds become progressively weaker until they die.

Method of contracting the disease.—In all forms of coccidiosis, the disease is spread by contamination of the feed, water, and soil with the droppings of fowls which harbor the parasites. The coccidia pass through certain stages of development in the outside world (fig. 15, B and C); later, when taken in the body of a bird in the act of eating or drinking, the organism continues its development, multiplying in large numbers (fig. 15, A).

As regards the transmission of coccidia to young birds through the egg, it appears never to have been demonstrated that the organisms may be included in the egg at the time it is formed. Even if such transmission



FIGURE 14.—Chick suffering from coccidiosis; cecal form.

were possible, it is improbable that it would happen frequently; it is much more likely that the organisms would be on the outside of the egg, the contamination of the eggshell occurring as the egg was passing out of the cloaca and vent. Turkey poults have often been found to start passing coccidia in their droppings within a week after removal from the incubator, even when they had been carefully protected from acquiring the infection, so that the only

source of the infection appeared to have been coccidia which were carried on the eggshell. As regards chickens, however, it is probable that coccidiosis is contracted by the young chicks much more frequently by other means than by transmission through or on the egg.

The organisms may be carried for considerable distances in running water or in dust, or on shoes, grain sacks, or other objects, or may be spread by birds or by flies or other insects which fly from one poultry yard to another; rats and mice also probably serve to spread the organisms. It has been found that a single organism is capable of producing a mild form of the disease, the organism multiplying in the chick's body and considerable numbers of the parasite later being passed in the droppings, so that as a result the infection is capable of spreading to the other chicks. It is apparent, therefore, that there are many ways in which a small amount of the disease-producing material may be spread.

Post-mortem findings.—If the course of the disease has been short, as sometimes happens in the acute form of coccidiosis, with death

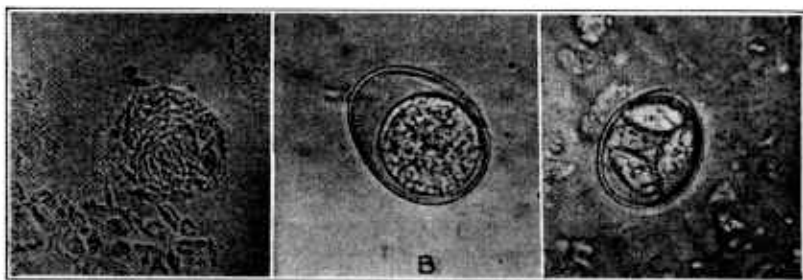


FIGURE 15.—Various stages of development of organisms which cause coccidiosis: A, Manner in which one organism gives rise to a large number of organisms in cecum of fowl; B, organism as passed in the droppings of fowl; C, organism which has developed to a stage which will infect the fowl. (After Johnson, 1924.)

occurring early, there may be no visible changes in the intestines; microscopical examination of the intestinal contents will show the presence of coccidia in some stage of development, however. If the disease is of longer duration, changes will have taken place, the nature of which will depend on the species of coccidia present, as noted above. In the acute form of coccidiosis in which the site of infection is in the blind guts, or ceca, these organs may be enlarged and filled with blood, and in later stages the cavity of the cecum may be plugged with a thick core, a yellowish, cheesy substance with dark bloody areas in it.

Treatment.—Many treatments have been tried and advocated for coccidiosis, but none have been completely satisfactory. This may be due partly at least to the fact that instead of one species of coccidia being involved, as was formerly thought, there are several.

Vinegar, 1 part, in water, 79 parts, given in nonmetal or asphalt-coated vessels as the only drinking water for about 12 days after first appearance of the disease, or quinine sulphate, 1 teaspoon to a gallon of drinking water, have been reported as beneficial in some cases, but results on a large scale are still needed before their value can be established. The same is true of some other drugs, as, for instance, carbon tetrachloride and also tetrachlorethylene, given in individual

doses of 1 to 1.5 cubic centimeters, which in the relatively small number of cases treated have been found to be effective in greatly reducing the numbers of coccidia in birds acting as chronic carriers; these treatments need additional study before they can be recommended.

Catechu was formerly thought to be of value in the treatment of coccidiosis, but critical tests have shown it to be ineffective. Cresol, formaldehyde, and areca nut, in each case given by mouth, are among other remedies shown to have no value in this respect. Efforts should be directed toward prevention, as outlined below, rather than reliance being placed on medicinal treatment.

Prevention.—Extensive studies of coccidiosis have brought to light two important facts: (1) That the severity of the disease depends on the number of organisms which are taken into the body of the fowl, and, (2) that the disease runs a limited course. In nonfatal cases the fowls recover, and the organisms usually disappear within a month's time, unless reinfection has taken place. Control measures which take these facts into consideration are therefore indicated.

Although there has been little success in the medicinal treatment of coccidiosis after it is fully developed, measures can be taken to prevent the development of the disease in chickens and to reduce its injurious effects if it appears. Strict sanitation, as described below, will reduce the number of organisms, and a well-balanced, nutritious diet will help build up the resistance of the fowls.

The feeding of a mash containing 40 percent of dried skim milk or 20 percent of milk sugar has been reported by the California Agricultural Experiment Station as effective in protecting young chicks from coccidial infection, the mash being fed during the period when the chicks are from 4 to 8 weeks old. The results of the use of this diet, however, have not been entirely consistent; in some cases it has failed to check the disease and has even appeared to produce injurious effects, such as pronounced diarrhea, with more or less prostration. The addition of egg rather than milk to the diet has been recommended as fulfilling the need of a tempting, nutritious diet for the chicks. Recent experimental work indicates that a well-balanced diet, rich in vitamins, is of value in the control of coccidiosis.

Daily cleaning is highly advisable, in order that the organisms which are being passed in the droppings may be prevented from developing to the stage which is infective. As a disinfectant for houses and yards, a 2- to 4-percent solution of liquor cresolis compositus or other coal-tar creosotes used in strong, hot solutions may be helpful; recent experimental studies indicate that spraying the litter with a mixture of coal-tar acids in a light mineral oil may also be of value. As the coccidia, however, are very difficult to destroy, cleanliness and the frequent removal of droppings containing the infectious material are highly important, and disinfectants must be regarded only as aids in connection with cleaning up. Coccidia need moisture for their development; hence thorough drying checks this development. They are susceptible to high temperatures also, boiling water destroying them quickly and hot water of somewhat lower temperature more slowly (a temperature of approximately 130° F. kills them in about 30 minutes). Practical measures based on these principles include: (1) Burning over the ground or runs; (2) the application of a layer of slaked lime to the ground; (3) putting

feeding troughs and drinking vessels into boiling water at frequent intervals; (4) burning carcasses of fowls which have died of the disease; and (5) burning or removing to remote areas the litter or other refuse which may be contaminated with infected droppings.

Raising chicks on raised wire-mesh floors, through which the droppings will fall, is probably the most effective preventive measure, but birds raised in this way must be kept away from infection subsequently, as they do not have the acquired resistance of birds which have passed through an attack of coccidiosis in early life. The screening of houses and runs in order to keep flies out and thus prevent their spreading the organisms is also of value.

TRICHOMONIASIS

Chickens may occasionally suffer from another disease, known as trichomoniasis, caused by a protozoan, *Trichomonas* sp., in the ceca; the disease, however, appears to be relatively less common and less severe than those previously described. Young chicks up to a month of age may die of the infection. The mildness or severity of the disease may vary with different strains of the organisms that cause it. The feeding of sour milk is said to be of value in the treatment of this disease.

PIGEON MALARIA

Cause.—A protozoan parasite, *Haemoproteus columbae*, which lives in the blood of pigeons, invading the red blood corpuscles, is the cause of pigeon malaria.

Spread of the disease.—Pigeon malaria is spread by the pigeon fly, *Pseudolynchia maura*, the latter being necessary for the transmission of the parasite from one bird to another. The fly in biting takes in the parasites with the blood of the bird; the parasites multiply and develop within the insect's body and are then introduced into a bird in the bite of the fly.

Symptoms.—The destruction of the red cells by the parasites may cause anemia, a condition in which the blood becomes less red, this in turn lowering the vitality of the birds. Aside from this there are no marked symptoms.

Prevention.—Prevention consists in the destruction of pigeon flies. The Bureau of Entomology recommends a thorough cleaning of the pigeon nests at intervals not to exceed 25 days, using a light spray of kerosene extract of pyrethrum in the interior of buildings, and one of the following procedures: Dusting the squabs and pigeons with fresh pyrethrum powder, Derris powder, or tobacco powder containing about 6-percent nicotine; dipping them with either an aqueous extract of pyrethrum with soap or Derris extract with soap and water; or using the kerosene extract of pyrethrum spray on the birds.

WORM PARASITES AND THE DISEASES CAUSED BY THEM

FLUKES

Flukes are small, flat worms, more or less resembling a leaf in shape. Their life histories always involve at least 1 intermediate host and sometimes 2. There are 2 different kinds of flukes which

have been found to cause disease in poultry in the United States and, although they are as yet rare in occurrence, they should be kept in mind as of possible importance in the future.

FLUKES CAUSING INJURY TO THE EGG-FORMING ORGANS

Parasite and the damage produced by it.—One species, *Prosthogonimus* sp., which has been found in chickens in Michigan, is red-

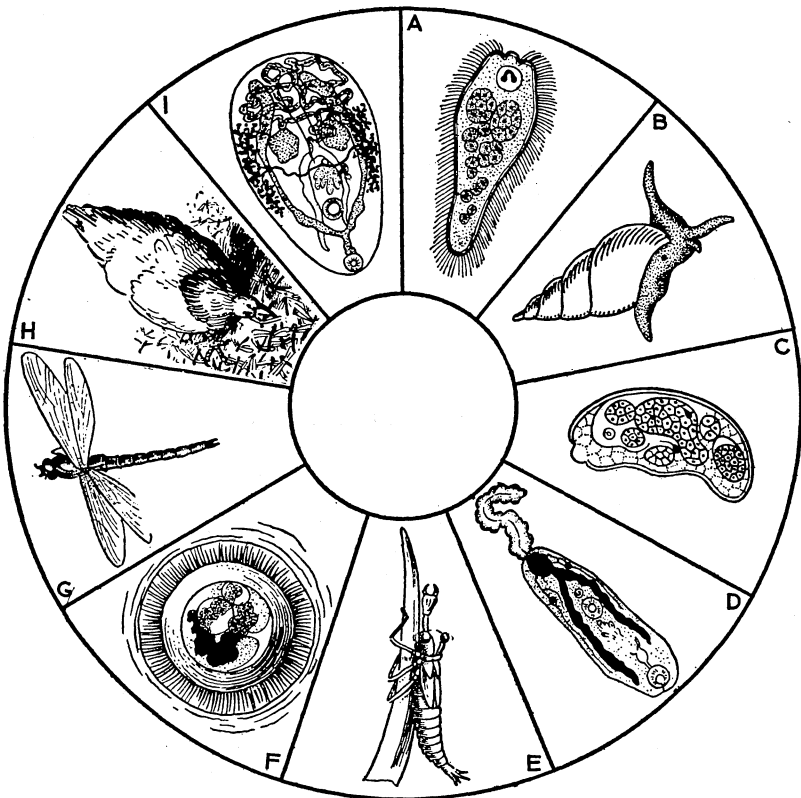


FIGURE 16.—Life history of fluke which attacks egg-forming organs of chicken. (After Szidat, 1929.)

dish in color and about a quarter of an inch long. Such flukes usually occur in the cloacal region, but they may invade the egg ducts and ovaries, causing serious injury to those organs. The symptoms shown by the fowls are dullness, loss of weight, and pallor. In Europe, closely related parasites have caused serious losses among chickens. It occurs always in the neighborhood of lakes or marshy places, such an environment being essential in its life history. The flukes may occasionally be found in eggs laid by infected hens.

Life history of parasite.—The life history of this parasite involves snails and also dragon flies, as shown in figure 16. The young worm (A), which hatches from the fluke egg, develops partially in the

snail (B), to a form of different appearance (C); then, leaving the snail as a tailed form (D), it swims around and burrows into the body of the young stage of the dragon fly, which lives in the water during its early life (E); in the insect the parasite forms a cyst (F); and, when the dragon fly is fully grown (G) and is eaten by the chicken (H), the worm develops to its adult form (I), from which the fluke eggs pass and begin the cycle again.

The parasite has been found in wild ducks and, therefore, it probably may be spread by them to domestic fowls.

Treatment and prevention.—Repeated doses of carbon tetrachloride, from 1.5 to 1.7 cubic centimeters of the drug, given in liquid cereal, are reported as a successful treatment for this parasite. To prevent chickens from becoming infected in an area in which the parasite occurs, measures should be taken to keep the fowls from eating dragon flies. Chickens probably capture the flies when the latter are still cold and inert in the early morning, and keeping fowls away from areas where these insects occur until the air has warmed would probably help to keep down infection. Otherwise, fowls should be kept away from wet places.

THE CYSTIC FLUKE IN THE SKIN

Another fluke, *Collyriclum faba*, has been found in cysts in the skin of chickens and turkeys in considerable numbers in Minnesota. In addition to injuring the general health of the fowl, the parasites produce blisters in the skin, the disfigurement reducing the market value of the fowl.

The parasite occurs also in the English sparrow and is probably spread by that bird. The life history is unknown.

TAPEWORMS

Description of parasite.—Tapeworms, or cestodes, are flattened worms made up of numerous divisions or segments, following a head region by which the tapeworm is attached to the intestinal wall. The tapeworm grows at the neck region, just behind the head, so that the segments farthest from the head are the oldest ones. When the tapeworm is fully developed, the oldest segments are filled with eggs and are spoken of as ripe or gravid segments; it is these segments which break off from the remainder of the worm and are passed in the droppings.

At least 10 different species of tapeworms are found in the United States in chickens, 9 or possibly 10 in turkeys, and several other species in the other domestic birds, such as ducks, geese, pigeons, and guinea fowls. The tapeworms vary much in size (fig. 17), some being so small that they are seen or found only with difficulty, whereas others are several inches in length.

Method of spread of tapeworms.—Tapeworms of poultry must pass part of their life history in an intermediate host, so far as these life histories have been definitely ascertained. This host is some small form of animal life which is eaten by poultry, either accidentally with feed or water, or actually as one of the items of feed. In the case of some of the tapeworms of poultry the nature of the intermediate host is as yet unknown, but in other cases it has been definitely ascertained that dung beetles, ground beetles, the house fly,

snails, slugs, and earthworms serve as hosts for various chicken tapeworms; grasshoppers probably serve as hosts for one of the turkey tapeworms.

Damage done by tapeworms.—One of the larger tapeworms, *Raillietina echinobothrida*, found in chickens produces in the intestine, especially in the lowest third of its length, numerous protuberances or nodules, which closely resemble the nodules caused by tuberculosis. If tapeworms are attached by the head to the inner surface of the intestine at the site of the nodule, such a condition may be ascribed to the worms. If tuberculosis is also present, there will probably be lesions in the liver.



FIGURE 17.—Seven different species of tapeworms from the chicken. Natural size.

In the case of other tapeworms, however, the injury to the intestinal wall is not so marked. Loss of weight, loss of appetite, a general condition of droopiness or unthriftiness, intestinal catarrh, and diarrhea are the conditions most frequently found associated with the presence of tapeworms. Young fowls are most seriously affected. Occasionally, lameness and paralysis have been associated with heavy infestations with certain tapeworms. If these conditions are caused by tapeworms, the removal of the worms will clear up the condition, but the same conditions may be caused by other things, and the finding of tapeworms associated with these conditions does not prove that there is a connection between them.

Treatment.—Kamala is the most effective drug known at present for the removal of tapeworms of poultry. However, it does not always remove the heads of some species of tapeworms; if segments

are again passing in the droppings, 2 to 4 weeks after treatment, repeat the treatment. Kamala is a brownish powder and is marketed in one form as a tablet, usually as a 1-gram tablet.

The drug should be used with caution; a few fowls from a flock should be treated first, to determine the effect, before all are treated. The use of kamala for chickens and turkeys occasionally has unfavorable results, such as loss of appetite, lowering of egg production, and even the occurrence of deaths among fowls, especially turkeys; the reason for such results, when millions of doses have been administered with no bad effects, is unknown, but one should not use kamala on birds which have blackhead, coccidiosis, white diarrhea, roup, or other diseases which lower the birds' resistance.

The average dose for a full-grown chicken is 1 gram, but this should be reduced if the fowls are in a weakened condition; for chickens that are not fully grown, give only a half dose. For turkeys, a 1-gram dose is advisable unless the birds are especially large and are known to tolerate the drug well, in which case a 2-gram dose may be given; for poults a reduced dose is preferable.

Prevention.—To prevent the spread of tapeworm disease, the droppings of the fowls should be disposed of in such a way that the known intermediate hosts of the parasite, such as beetles, flies, slugs, snails, and earthworms, are kept from eating the eggs or segments of tapeworms passed in the droppings of infested fowls; and poultry should be prevented from eating these intermediate hosts which may be carrying larval stages of tapeworms. Prompt removal of droppings, keeping the yards and houses free of trash, boards, boxes, and other unnecessary objects, and the filling in or liming of damp places near feed and water vessels, which places may serve as hiding or breeding places for the intermediate hosts, are valuable preventive measures. The plowing up of pens and seeding them to short growing vegetation, rather than leaving them in a weedy, fallow condition, helps to reduce the number of ground beetles.

In some places poultrymen have resorted to raising chickens in confinement, under screen, and on raised floors, in order to prevent their becoming infested with tapeworms. Certain of the beetles, however, which are known to serve as intermediate hosts are considerably smaller even than house flies, so that in case of screening the mesh of the screen must be fine enough to keep out such small insects, to be thoroughly satisfactory.

In order that poultry droppings may not be wasted but may be used for manure, without danger of spreading worm infection, it is recommended that the droppings be stored for a while, as previously described.

ROUNDWORMS

EYE WORM OF POULTRY

The parasite, *Oxyuris mansoni*, known as Manson's eye worm, is known to have been present in Florida for many years and has recently spread to Louisiana. It occurs in chickens, turkeys, and peafowls, and can develop in various wild birds. The parasite is found under the nictitating membrane, that is, the transparent membrane which passes over the eyeball of the fowl in the act of winking.

The worms are slender and colorless and are about three fourths of an inch long; they can often be detected by a firm pressing of the tear sac at the inner corner of the eye, when they will wiggle out over the eyeball.

Symptoms and damage produced by parasite.—Affected fowls wink the eye continuously and frequently attempt to rub the head on the feathers of the wing, or to scratch at the eye with the foot. The eyesight is not good. There is puffiness around the eye, and a discharge from the eye and from the opening of the nose. There is often a severe inflammation which may result in blindness; at times the entire eyeball is destroyed.

Life history of parasite.—This roundworm has an indirect life history, and its intermediate host has been shown by workers of the Florida Agricultural Experiment Station and elsewhere to be a cockroach, *Pycnoscelus surinamensis*. The cockroaches are found beneath boards and trash and in the vegetation at the edges of the fences; they feed on whatever food material is present, including the droppings of the fowls. From the droppings the cockroaches obtain the eggs or newly hatched larvae of the roundworms, the eggs having been washed down the tear ducts from the eye of the fowl and having then been swallowed and passed in the droppings. The young roundworm develops in the body of the cockroach and when the roach is eaten by a fowl the worm is freed in the bird's crop. It passes up the esophagus to the mouth and then through the tear ducts to the eye.

The cockroach which spreads the parasite in this manner in Florida and Louisiana also occurs in Texas, and in certain places in the North it has been found in greenhouses. There is danger, therefore, that the eye worm may spread to States other than Florida and Louisiana. By the feeding of cockroaches containing the young stages of the worms, the eye worm has been experimentally developed in ducks, bobolinks, a blackbird, a pigeon, a loggerhead shrike, and a blue jay; such birds as these must, therefore, be considered possible carriers of the roundworm in areas in which it is found in poultry.

Prevention.—The removal from the chicken yard and houses and from the area around the yards, of all trash, boards, boxes, and other unnecessary objects, which may serve as hiding places of cockroaches, is probably the most important control measure. Roaches which come from the outside into a clean yard, free from objects which may serve as hiding places for them, are likely to be eaten promptly by the chickens before the roaches have a chance to become infected by eating the chicken droppings. Such uninfected roaches will not cause worm infestation. Hiding places enable the roaches to become infested and to infect the chicken which subsequently captures them. The daily collection of droppings and their removal to a place where cockroaches cannot get at them is a measure of value. Affected birds should either be treated and cured or killed and destroyed.

Treatment.—The Florida Agricultural Experiment Station recommends the following as the most effective treatment: Drop into the eye of the fowl a 5-percent solution of butyn as an anaesthetic; then lifting the nictitating membrane of the eye, place 1 or 2 drops of a 5-percent solution of creolin directly on the worms. Immediately after applying the creolin, wash it out well with water; the worms will have been promptly killed by it.

GAPEWORM OF CHICKENS AND TURKEYS

A roundworm which produces unmistakable symptoms of disease is the gapeworm, *Syngamus trachea*. This parasite occurs in turkeys and chickens but with a decided difference in effects. As a rule, the gapeworm will live in chickens only when the chickens are very young, the first few weeks of life being the danger period. The chicks that live through the acute stage of gapeworm disease soon lose the worms, and, therefore, do not remain carriers. On the other hand, adult as well as young turkeys commonly harbor gapeworms and usually show no bad effects, and it is apparently the infested turkey that is the chief cause of the spread of gapes to chicks. Young turkey poults suffer from gapes only rarely, and it is very unusual to find gapeworms in a mature chicken.

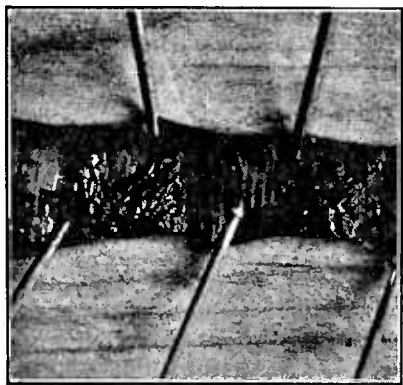


FIGURE 18.—Gapeworms in windpipe of chick. (After Hall, 1916.)

Gapeworms are attached to the wall of the windpipe or trachea, on its inner surface (fig. 18). The male and female worms are joined together so that the two worms form a Y.

Symptoms and damage produced by parasite.—The worms clog the windpipe of chicks, and because of an insufficient supply of air young chicks which have gapeworms in the windpipe will open the beak and gape; this behavior has given rise to the name “gapes”,

as applied to the disease. There is often a convulsive shaking of the head, with a hissing cough. This continuous effort to obtain air prevents the chicks from feeding; this and also the fact that the worms are bloodsuckers weaken the chickens so that they become thin and pale. Death may result from suffocation or from general weakness.

Life history of the parasite.—This parasite has a direct life history. Eggs of the parasite are coughed up from the windpipe and swallowed by the chicken or turkey which harbors the worms. These eggs pass out in the droppings, develop, and some of them hatch. Either the infective eggs or the young roundworms which hatch from them may then be swallowed by fowls in the act of feeding or drinking. Within a week the young worms will have reached the lungs, and from there they work their way up into the windpipe and may be fully developed within another week or 10 days.

Earthworms may play an important part in the spread of gapes. The infective eggs or the young gapeworms which have hatched in the soil from the eggs in the fowls' droppings may be eaten by earthworms; they burrow into the body muscles of the earthworm and may remain alive for considerable periods. The earthworm in these cases is not a necessary intermediate host of the parasite; it is merely a mechanical carrier or reservoir, protecting the young gapeworms from conditions such as drought and high and low temperatures, conditions which would otherwise kill the young parasites.

Earthworms may thus carry the young gapeworms over from one warm season to another.

Another important factor in the spread of gapes is the fact that turkeys may carry gapeworms throughout their whole life and thus may spread them to young chickens, if turkeys and chickens are being raised together.

Prevention.—Raising young chicks entirely separate from turkeys and areas ranged by turkeys is the most important preventive measure. If gapeworm disease has been present in the vicinity, dry, sandy soil should be selected for young chicks to run on, since such soil is unfavorable to earthworms; or young chickens should be shut up until the dew has dried off in the morning, when most of the earthworms which have come to the surface will have disappeared.

Treatment.—No treatment has been found to be thoroughly satisfactory. Mechanical removal, although a slow, difficult, and rather dangerous procedure, may be accomplished by the insertion of a loop of horsehair down the windpipe and the rotation of the loop in such manner as to dislodge the worms from the wall and entangle them in the hair, which is then withdrawn. A small quill feather, which is stripped of all its web except a small tuft at the end, may also be used in place of the hair; a little kerosene or oil of turpentine put on the feather will aid in loosening the worms and later will cause the chick to sneeze or cough and thus help to bring up the worms. Wire extractors made by commercial firms are used in the same manner.

Various medicinal treatments have been advocated, but none can be regarded as of proved value.

CROP WORMS

There are two different kinds of roundworms which occur in the crop, and occasionally also in the undilated esophagus of chickens and turkeys. Both kinds are sewed into the walls and have the appearance of a wavy, white thread. The worms move around inside the wall and form burrows or tunnels.

One of these roundworms, *Gongylonema ingluvicola*, is comparatively rare, and is not known to injure the health of the fowl aside from slight local damage to the wall of the crop. This roundworm has an indirect life history, the intermediate hosts being dung beetles.

The second crop worm, *Capillaria annulata*, has been found more recently in this country, but appears to be of much more common occurrence. In severe cases these roundworms may be present in large numbers and may greatly damage the walls of the crop and the undilated esophagus (fig. 19). They interfere with digestion, and the fowls become progressively weaker and finally may die from the effects of the parasite. This roundworm probably has a direct life history, the eggs which pass out in the droppings developing to a stage which will infect the fowl swallowing them in contaminated feed or water. This life history has not yet been experimentally demonstrated, but in the case of a closely related species, *C. contorta*, which occurs in domestic ducks in Europe and in wild ducks and gallinaceous game birds (pheasants) in this

country, direct experimental transmission from one bird to another has been accomplished.

Prevention of crop worms.—General sanitary measures such as described on page 37 are advised.

Treatment.—The feeding of soft, highly nutritious feeds in place of grain is of value in overcoming the effects of crop worms. No medicinal treatment has yet been developed. Worms which have burrowed into the crop are more or less protected from the action

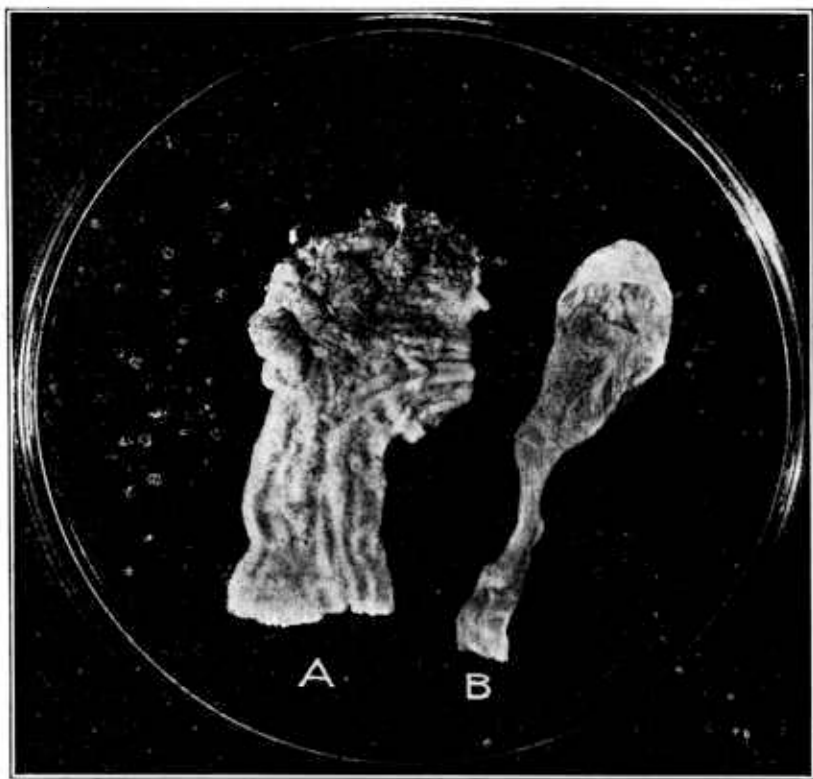


FIGURE 19.—A, A crop heavily parasitized by the crop worm, *Capillaria annulata*; B, a normal crop. Note, on the extreme left, the threadlike worms which caused the injury.

of drugs. Carbon tetrachloride or tetrachlorethylene in fairly large doses (from 2 to 5 cubic centimeters), given when the crop is empty, may be of value if the damage to the wall of the crop has not been too severe. (See p. 56 for administration of these drugs.)

STOMACH WORMS

In the two stomachs of domestic birds, that is, in the proventriculus or glandular stomach and in the gizzard or muscular stomach, several different kinds of roundworms may be found.

THE TETRAMERE OF CHICKENS

The parasite, *Tetrameres americana*, shows very strikingly differences from most other roundworms. The usual slender, elongated

form of roundworms is lost in the case of the female tetramere (fig. 20). While young these parasites enter the glands of the stomach and as they develop to adults the large number of eggs which form within the body causes it to swell until it is practically globular in shape; also, its color changes to bright red. These parasites may be present in adult fowls without any apparent injury to the health of the fowl. In young chicks, however, they interfere with the proper digestion of food, so that general weakness and diarrhea, and even death, may result.

Life history.—The tetramere has an indirect life history and the intermediate hosts have been found to be grasshoppers and cockroaches.

Prevention.—Raising young chicks in such a way that they cannot feed on grasshoppers or cockroaches which may have had access to the droppings of older, infected chickens, and disposing of droppings so that the worm eggs in them are destroyed or that insects cannot get at the droppings, are the most important preventive measures.

Treatment.—A soft, highly nutritious feed, rich in vitamins, has been found to help chicks to overcome the bad effects of this parasite. No medicinal treatment is known; that suggested above for crop worms may be of value in this connection.



FIGURE 20.—A tetramere from the glandular stomach of a chicken. Enlarged about four times.

THE SPIRAL STOMACH WORM

A short, white roundworm, *Dispharynx spiralis*, which is curved or even twisted in a spiral, is found occasionally in the glandular stomachs of chickens, turkeys, and pigeons, as well as in gallinaceous game birds, in this country, and if present in considerable numbers may seriously affect the health of the bird. The more evident symptoms are droopiness and loss of weight, in spite of the fact that the birds have a ravenous appetite even up to the time of death. In pigeons the eye has been said to lose its color when the birds are suffering from the effects of this stomach worm. The stomach may be considerably enlarged and the glands of its walls may be partly or almost completely destroyed.

Life history.—This roundworm has an indirect life history, and sow bugs, or pill bugs, have been found to be the intermediate hosts.

Prevention.—Measures which will eradicate sow bugs from the premises, so that the birds cannot eat them, are of great importance. Keeping the birds in dry, light quarters and the removal of unnecessary objects under which the sow bugs may hide are of value in this connection. The proper disposal of droppings, either to destroy worm eggs or keep them from all intermediate hosts, is important.

Treatment.—No satisfactory treatment is known, although that suggested previously in the case of the tetramere, and also in the case of crop worms, may be of value.

GIZZARD WORM OF CHICKENS AND TURKEYS

A slender, white, gizzard worm, *Cheilosporura hamulosa*, about one half to three fourths of an inch long, has been the cause of deaths of chickens in this country, and has also been found in turkeys. It

passes through the horny lining of the gizzard, leaving small, round holes with raw, raised edges (fig. 21), and burrows into the muscular wall, producing tunnels in the wall or causing the formation of wart-like growths on its surface. Eggs of the parasite pass out of the holes and mix with the gizzard contents, eventually being discharged by the bird in its droppings. The wall of the gizzard may be so badly damaged by these worms that the digestion of food is interfered with and the health of the fowl consequently suffers from it.



FIGURE 21.—Holes made by gizzard worm in the horny lining of gizzard of chicken.

Life history.—This roundworm has an indirect life history and its intermediate hosts have been found to be grasshoppers.

Prevention.—Sanitary measures, such as frequent collection and proper disposal of droppings so that grasshoppers may not feed on them and thus become infected with the early stages of the roundworm, and secondly, measures to prevent the fowls from eating grasshoppers, are advised. Confining fowls to runs which have been sown to a short, thick, green vegetation, such as grass, rather

than allowing them to range in long, dry vegetation which is favorable to grasshoppers, helps to reduce the number of these insects eaten by the fowls.

Treatment.—Unknown; that suggested for the tetramere and for crop worms may be of value in this connection.

GIZZARD WORM OF DOMESTIC GESE AND DUCKS

In domestic geese and ducks a small, slender roundworm, *Amidostomum anseris*, sometimes reddish in color from blood which it has swallowed, may be found burrowing in the horny lining of the gizzard; it does not invade the wall to so great an extent as does the gizzard worm of chickens and turkeys, but causes more damage to the surface. There is considerable loss of blood by the bird, and the gizzard lining shows roughened areas stained brown from blood. The parasite may produce poisons which also weaken the bird. Numerous deaths may occur in flocks in which these parasites are present in large numbers.

Life history.—This roundworm has a direct life history. The eggs pass out in the droppings, young roundworms hatch from them, and, after being taken in by the birds in the act of eating or drinking, the worms develop to adults in the gizzard. This parasite has been transmitted experimentally from the domestic goose to the domestic duck in this manner.

Prevention.—Sanitary measures which prevent the contamination of feed and water with the droppings of infected fowls are of value.

Treatment.—This parasite has been successfully removed from young geese by administering to each bird a 1.5 to 2 cubic centimeter dose of carbon tetrachloride, given in about 8 cubic centimeters (about 2 teaspoons) of liquid cereal.

INTESTINAL ROUNDWORMS

LARGE ROUNDWORM OF THE INTESTINE

The large roundworm or ascarid, *Ascaridia galli*, found commonly in chickens and less commonly in domestic ducks, geese, and turkeys, occurs in the small intestine and attains a length of from 1 to 4½ inches when fully grown (fig. 22). These worms may be present in such numbers as to block the intestines. Large numbers of the young worms may kill chicks in from 10 to 12 days. The parasites stunt the growth of the chick and prevent proper bone development, so that weakness results (fig. 23). Young chicks are most seriously affected by this roundworm. If the chick does not become infected until after it is 3 months old, the parasites do less damage to it. Grown fowls which harbor this parasite may be unthrifty and their egg production low.

The adult worms occasionally wander up the oviduct and are trapped in the hen's egg as it forms.

Life history.—The life history of this parasite is direct. The eggs of the parasite pass out into the soil in the droppings of the fowl, and the young stage of the worm develops within them in a period of about 15 to 20 days under favorable conditions. The young worm hatches from the egg when the latter is swallowed by a fowl. The young worms may burrow into the inner surface of the wall of the intestine, causing damage to the glands, for a period extending from about the tenth to the twentieth day after the egg is swallowed. Then the worms return to the interior of the intestine to develop into adults in about 2 months.

The eggs of the parasite are thick-shelled; they are resistant to cold but more easily killed by heat. In Kansas, the high temperature of summer has been found to kill all the eggs of this parasite on the surface of the soil and to a depth of 6 inches in unshaded places, but in shaded spots the eggs survived.

Prevention.—General sanitary measures should be adopted to prevent the worm eggs from developing in the soil and later being swallowed by the fowls. Rotation of runs has been found valuable. Special protection of chicks until they are 3 months of age, by raising them away from older chickens or areas ranged by such chickens, will prevent the greatest injury. A nutritious diet, rich in vitamins, has been found to be helpful in building up the resistance of the chick to this parasite.

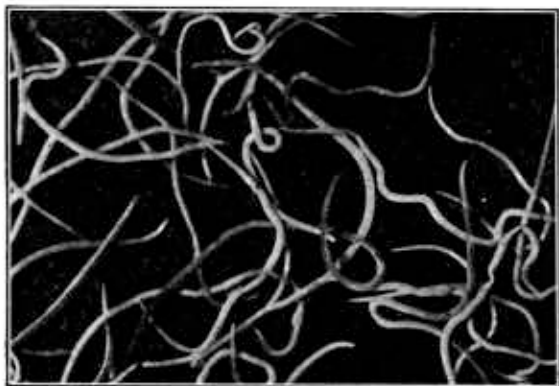


FIGURE 22.—Roundworms (*Ascaridia galli*) from the small intestine of a chicken. (Courtesy J. E. Ackert.)

Treatment.—The quickest and most effective treatment for the removal of the large roundworm consists in the individual dosing of each bird with carbon tetrachloride or the closely related drug, tetrachlorethylene, using a 1-cubic centimeter dose for adult birds; for young chickens, however, the dose must be reduced and given with caution. The drug is most easily given in gelatin capsules, although it may be introduced directly into the crop through a soft-rubber tube passed down the esophagus. Care must be taken that the drug does not get into the lungs, as in that case it may be quickly fatal. When both large roundworms and tapeworms are present, a 1-cubic centimeter dose of tetrachlorethylene, followed in 3 days by a 1-gram dose of kamala, is a satisfactory treatment for removing both kinds of parasites.

Another individual treatment consists in the administration, to each bird, of a no. 2 capsule containing 0.35 gram of a mixture of 6.6 cubic centimeters of 40-percent nicotine sulphate and 16 grams of Lloyd's alkaloidal reagent, which is a selected fuller's earth.

For mass treatment rather than individual treatment the California Agricultural Experiment Station recommends the following:

Add to the mash 2 percent by weight of tobacco dust containing at least 1.5 percent of nicotine, and feed this mixture to the flock for a period of 3 or 4 weeks. Treatment may be repeated at 3-week intervals as often as necessary.

If a single-dose treatment is desired for the removal of the large roundworm, the California station recommends the use of 1 teaspoon of oil of chenopodium, thoroughly mixed with a moist mash, for each lot of 12 birds.

LARGE ROUNDWORM OF PIGEONS

In the intestine of pigeons may be found a large roundworm which closely resembles that found in chickens, but it is a different

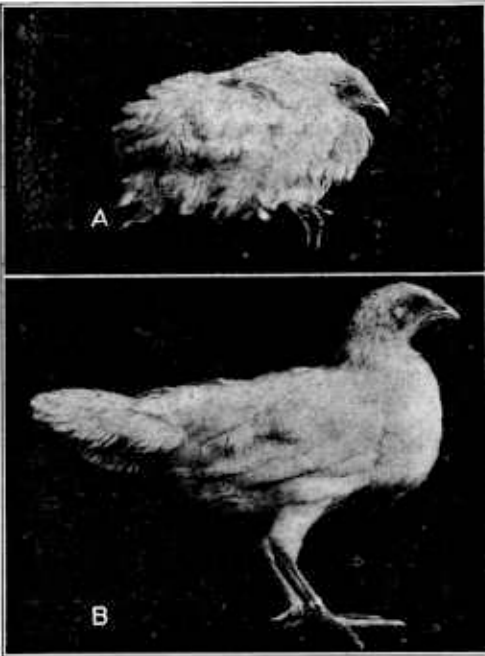


FIGURE 23.—A, Chicken suffering from large roundworms of the intestines, unable to recover from parasitism. B, control from same hatch; aged nearly 4 months. (After Ackert and Herrick.)

species, *Ascaridia columbae*. This parasite may be present in large numbers, as many as 500 having been collected from one pigeon. The worms are sometimes found to have wandered into the stomachs and even up into the esophagus. The life history is probably similar to that of the large roundworm of chickens and preventive measures would be similar in the two cases, with modifications to meet the different conditions under which pigeons are raised.

Treatment.—Carbon tetrachloride in repeated doses of from 1 to 2 cubic centimeters, given in liquid cereal or in liquid paraffin, has been satisfactory for the removal of this parasite. The pigeons may occasionally regurgitate the drug.

COMMON CECUM WORM, OR HETERAKID, OF POULTRY

The common cecum worm of poultry is also known as the heterakid, *Heterakis gallinae*; it occurs in the ceca, or blind guts, of chickens, turkeys, guinea fowls, and domestic ducks and geese. This worm attains a length of from three tenths to one half inch. The worms are sometimes present in enormous numbers and may cause a serious inflammation of the ceca, especially in young chicks. As already noted, they are apparently involved in the transmission of blackhead in the presence of infective blackhead material.

Life history.—The life history of this roundworm is direct, the eggs developing in the soil in a period of from 7 to 12 days under favorable conditions. They are very resistant to freezing and to drying. The young worm hatches from the egg when it is swallowed by a fowl. The young worms invade the wall of the ceca for a short period, and may do considerable damage at this stage; later they return to the interior of the ceca and develop to adults in about 24 days after entering the fowl's body.

Earthworms may be a factor in spreading cecum worms and other worms; the eggs of the roundworms may be eaten by the earthworms and later reach fowls by being passed in the casts of the earthworms and thus infecting otherwise uninfected soil, or by the earthworms being eaten by the fowls.

Prevention.—As in the case of the large roundworm, general sanitary measures, rotation of yards, and special protection of young chicks are of value in preventing infestations with this parasite.

Treatment.—The tobacco-dust treatment for the large roundworm will remove about 80 percent of the common cecum worms, if continued for a month.

An individual treatment, which will remove about 90 percent of the worms, consists in the use of rectal injections of oil of chenopodium in a bland oil, such as cottonseed oil. The dose is 0.1 cubic centimeter of oil of chenopodium in 5 cubic centimeters of cottonseed oil for a bird weighing 1½ pounds. Probably double this dose would be effective for a bird weighing 3 pounds or more. This mixture may be made up at the rate of 1 teaspoon of oil of chenopodium in 6 fluid ounces of cottonseed oil and given at the rate of one third of an ounce to birds weighing 3 pounds or more, a proportionately smaller dose being used for smaller birds. The two ingredients should be thoroughly mixed and given with a hard-rubber enema syringe. It is as easy to give this treatment by rectum as it is to give a treatment by mouth. The tip of the syringe should be passed along the floor of the cloaca, which is the common passage into which the intestine and the egg tube open, and the mixture injected slowly.

OTHER ROUNDWORMS OF THE INTESTINES

There are several different species of hairworms, or capillarids, *Capillaria* spp., which occur in the small intestine and ceca of do-

mestic poultry, all kinds of domestic birds being known to harbor such worms at times. The worms are very slender and colorless, usually from one half to three fourths inch long, and are found with difficulty unless present in large numbers. They may seriously affect the health of the fowls. Carbon tetrachloride given in a 1-cubic centimeter dose, and repeated about 7 days later, has been effective in removing some kinds of capillarids. The life history is direct and general sanitary measures should be adopted to prevent reinfestation.

In pigeons a serious disease may be caused by a delicate, slender roundworm, the pigeon strongyle, *Ornithostrongylus quadriradiatus*, which occurs in the small intestine. The worms are blood suckers, and the loss of blood by the bird is probably responsible for the severity of the effects of this disease. A treatment which has been reported as effective in expelling these worms consists in giving each pigeon 5 centigrams of thymol, three doses being given on alternate days and followed by a capsule of castor oil.

In chickens an extremely small roundworm, the chicken strongyloides, *Strongyloides avium*, has been found in the ceca; in young chicks especially, it may seriously affect the health. The walls of the ceca may be greatly thickened, and a bloody diarrhea may be present. If the chicks survive this acute stage, they may show no bad effects from the parasite, even though it is present, when the chickens are fully grown. The life history of this parasite is direct, but, unlike the direct life histories of other roundworms of poultry, this one includes stages in which the worms develop in the soil to adult males and females, which give rise to young. No treatment has yet been developed for removing this parasite. Special protection of young chicks and general sanitary measures are of value in preventing the spread of the parasite.

LICE

There are at least seven different species of lice occurring on domestic chickens, while still other forms occur on turkeys, ducks, and guinea fowls. As different species of lice are usually confined to different parts of the body and feathers, they are commonly referred to as head lice, wing lice, body lice, shaft lice, and fluff lice, although the distinction is not very exact, since the various species intermingle to some extent.⁵

LICE ON CHICKENS

The two most important lice on chickens are the head louse, *Lipeurus heterographus*, and the body louse, *Menopon biseriatum*. The head louse (fig. 24) is most injurious to young chicks. It occurs on the head at the base of the feathers or the down; it passes readily from one chicken to another, and from the hen to her chicks. It is important to treat the hen for lice before the hatch comes off. Treatment, as given below, should be applied to the head. The body louse is most injurious to grown fowls but occasionally affects young chicks. It causes irritation to the skin, with at times the formation

⁵ Farmers' Bulletin 801 contains more detailed information regarding lice and their control.

of scabs or blood clots. It is found directly on the skin, the most favored site being just below the vent, but head, neck, legs, and body may show the presence of these lice.

The shaft louse, the wing louse, and three other less common species are not so serious a menace to chickens.

LICE ON TURKEYS

Four species of lice are found on turkeys; two of these are species which also occur on chickens, whereas the other two are restricted to the turkey. The common body louse of chickens may cause considerable irritation to both young and grown turkeys; the shaft louse of chickens may be present, without evident bad effect. The two species which are found on turkeys only, the large louse, *Goniodes stylifer*, and the slender turkey louse, *Lipeurus polytrapezius*, may be markedly injurious to poults and may cause severe annoyance to adult birds.

LICE ON DUCKS AND GEES

Young ducks which are hatched by hens may suffer from the head louse of chickens. There are also at least three species of lice which are restricted to ducks and geese, but they are seldom present in sufficient numbers to cause noticeable annoyance.

LICE ON PIGEONS

There are two species of lice, different from those found on other domestic birds, which cause considerable annoyance both to old birds and to partially feathered squabs.

LICE POWDERS AND THEIR APPLICATION

Experiments conducted by the Bureau of Entomology have shown that a very satisfactory way of eliminating lice from poultry is to treat each fowl separately with sodium fluoride. If applied to all fowls as directed, one treatment is sufficient to kill all lice and their eggs. Commercial sodium fluoride may be purchased at most drug stores at from 30 to 60 cents a pound and may be applied either by the so-called "pinch" method or by means of a duster made by punching small nail holes in the bottom of a can having a tight-fitting cover, or by dipping. If the pinch method is used, the bird is held on a table while sodium fluoride is applied next to the skin under the feathers, as follows: One pinch under the head, 1 on the neck, 2 on the back, 1 on the breast, 1 below the vent, 1 on the tail, 1 on each thigh, and 1 on the under side of each wing. The feathers should be ruffled to allow the powder to get next to the skin. If the bird is held in a large, shallow pan, the small quantity of powder which falls off will be saved. If the powder is dusted on by means of a shaker the quantity of sodium fluoride used may be reduced by using 3 parts of road dust

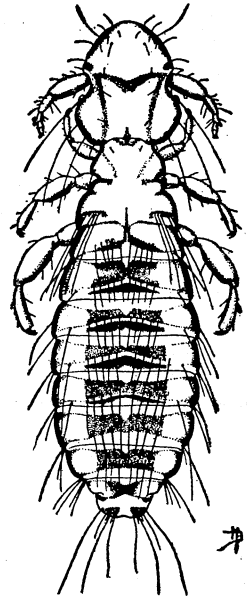


FIGURE 24.—The head louse, male, top view. Greatly enlarged.

or flour to 1 part of the chemical. This method requires the services of a second person to hold and turn the fowl.

When considerable numbers of birds are to be treated the sodium fluoride should be used in the form of a dip, 1 ounce of commercial sodium fluoride being used to each gallon of water. The birds should be held by the wings and plunged into a tub filled with the solution, the head being left out, while the feathers are ruffled with the hand to allow the solution to penetrate to the skin. The head is then ducked once or twice and the bird held for a few seconds to drain, and then released. Dipping is just as effective as the other methods and is quicker and more economical of material. Dipping should be done only on warm, sunny days.

To sick fowls or to very young chickens or turkeys, sodium fluoride should be applied only by the pinch method, and especially in the case of young birds it should be used cautiously, in very small pinches.

One pound of sodium fluoride will treat 100 birds by the pinch method. Figuring a person's time at 40 cents an hour and the drug at 40 cents a pound, it has been estimated that it costs about \$2 to treat 100 fowls. The cost of treatment by dipping is about one half of this amount, and the irritating effect of the powder on the operator is avoided.

Another good lice powder is flowers of sulphur, which should be applied with a duster. Although sulphur is considerably cheaper than sodium fluoride, it is less effective against lice and hence must be applied more liberally, so that its use is in reality more expensive than sodium fluoride. Many other powders, most of which contain pyrethrum (insect powder), are commonly used, but they have no advantage over sodium fluoride.

Dust baths containing a mixture of tobacco dust or other insecticides and ordinary road dust are often recommended to destroy lice. While it is a good plan to let the birds dust themselves when they wish, no method which allows the bird to treat itself for lice can be expected to eradicate them all, since fowls cannot get the dusting powder on all parts of the body where lice are, and many lousy birds will not use the dust baths.

A simple procedure which is effective in controlling lice but will not eradicate them consists in the application of undiluted 40-percent solution of nicotine sulphate to the top surface of the roosts by means of a paintbrush. This is done a short time (from 15 to 20 minutes) before the fowls go to roost. The fumes of the nicotine kill the lice during the first, second, and third nights after application. The head lice, naturally, are least affected. As some of the lice are not killed and the eggs are not destroyed, it is necessary to repeat the treatment frequently.

It is possible and practicable to keep a flock of poultry absolutely free from lice and mites, and this should be the aim of everyone who is endeavoring to establish a successful poultry flock.

MITES*

COMMON RED MITE

While there are many kinds of mites affecting poultry, there are three which are of special importance to poultry raisers, the best

* For further information on poultry mites consult Farmers' Bulletin 801.

known being the common chicken mite or red mite (*Dermanyssus gallinae*). In the Northern States this mite is dormant in winter, except in chicken houses which are heated, but in the South it breeds and is active the year round, although it is always most abundant in summer. Unlike the other mites affecting poultry, this parasite, with few exceptions, is found on the birds only when it is feeding (fig. 25). It is nocturnal in habits, feeding at night and hiding during the day in the cracks of the roosts, in the nests, in the corners of the floor, or between boards. For this reason its presence often remains undetected until the chicken houses are badly infested and the poultry raiser seeks an explanation for the drooping condition and listlessness of his fowls.

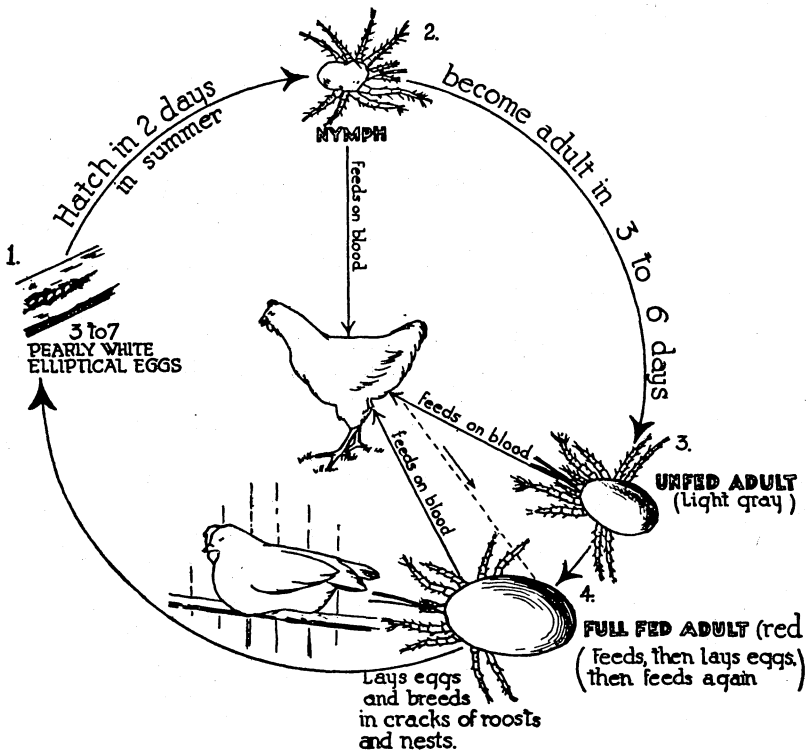


FIGURE 25.—Diagram showing the life habits of the common chicken mite.

Treatment.—To eradicate the pest a thorough cleaning of the chicken houses and spraying with a suitable insecticide having a sufficient body is all that is necessary. All roosts, loose boards, and boxes should be removed and the insecticide applied in the form of a rather coarse spray, using a suitable pump. One of the best substances for the purpose is anthracene oil. As this is a little too heavy to spray well, it may be thinned with an equal quantity of kerosene, or the undiluted material may be applied with a brush to the roosts, roost supports, nest boxes, and other places where the mites are found. High-grade creosote also gives satisfactory results. Crude petroleum is nearly as effective and is usually cheaper. It should be thinned

by adding 1 part of kerosene to 4 parts of crude oil. Pure kerosene, kerosene emulsion, and carbolic acid, when brought in contact with the mites, will kill them, but as they all lack sufficient body for persistence the spraying must be repeated several times, making the use of these materials impracticable. The coal-tar dips, used in a slightly stronger solution than recommended on the labels, will be effective if the application is repeated, and the germicidal properties are a desirable feature. Whatever preparation is used, the birds should be kept out of the houses until the fluid has thoroughly soaked into the wood.

DEPLUMING SCABIES

Fowls and pigeons are sometimes infested by an itch mite, *Cnemidocoptes gallinae*, which lives at the base of the feathers, causing an intense itching and producing a disease known as mange or depiluming scabies. The irritation caused by the mites leads the fowls to pull out their feathers, and they often acquire the habit of feather pulling, attacking the plumage of other birds as well as their own. If the stumps of the feathers are examined soon after the breaking of the quill, they will be found surrounded by scales and crusts, and the adjoining feathers when pulled out will be found similarly affected. In this way the condition can easily be distinguished from molting or the vice of feather pulling, which fowls sometimes acquire without apparent cause. The mites causing the disease are introduced into the poultry yard by affected fowls and spread rapidly from fowl to fowl, finally infesting nearly all in the flock. The disease usually begins in the spring, is most active in warm weather, and largely disappears in winter.

Treatment.—Complete control may be effected by dipping the entire flock in a tub of water containing 2 ounces of flowers of sulphur and one half ounce of laundry soap to each gallon of water. If the fowls are also infested with lice, the two pests may be eliminated with a single treatment by dipping in this mixture, to which has been added three fourths of an ounce of commercial sodium fluoride. As the depiluming mite is well protected by the skin scales, it is necessary to soak the fowls thoroughly to destroy all the mites. As a soapy mixture of this kind completely wets the plumage, special care must be taken to do the dipping on a warm day when there is little wind. When the infestation is limited to a few birds, or when for other reasons it is not desired to treat the whole flock, the trouble may be held in check by applying to the affected parts an ointment made by thoroughly mixing 1 part of flowers of sulphur with 4 parts of vaseline or lard.

THE FEATHER MITE

Infestations of the feather mite, *Liponyssus silviarum*, have occurred in many flocks during the last few years; it is very injurious in the northern part of the United States. This mite closely resembles the common chicken mite, but has very different habits in that it breeds among the feathers. The eggs are deposited and hatch among the feathers where the young mites may complete their entire development without leaving the fowl. These mites are to be found in greatest numbers below the vent, about the tail, and sometimes on the neck. The feathers often have a dirty appearance from

the presence of the mites, and the skin may be irritated and scabby from the bloodsucking habits of the parasites. The feather mite may first be detected on the hens' eggs, their presence there in large numbers being said to be a characteristic sign of infestation with this mite. These mites have been found in the nests of English sparrows near infested chicken houses.

Treatment.—Feather mites may be destroyed by dipping affected fowls in a tub containing a mixture of water, 1 gallon; flowers of sulphur, 2 ounces; and soap, 1 ounce.

The feathers should be thoroughly wet to the skin. The head should be submerged for an instant. During the dipping process the mixture should be stirred so as to keep the sulphur in suspension. Dipping should be done only on warm, sunny days, or in a heated building. If treatment is found to be necessary during the winter or early spring months thorough dusting of the fowls with flowers of sulphur should take the place of dipping.

The nesting material should be removed and burned, and nest boxes, roosts, walls, and floor should be sprayed or painted with anthracene oil as recommended for use against the common chicken mite.

A simpler method than the one just mentioned, reported as satisfactory in some cases but not so successful in others, consists in painting the perches with a 40-percent nicotine-sulphate solution shortly before the fowls go to roost, and dusting the nests with sulphur. Nests of English sparrows in the immediate vicinity of the poultry house should be destroyed.⁷



FIGURE 26.—Scaly leg.

SCALY LEG; MANGE OF THE LEG

Another species of itch mite, *Oenidocoptes mutans*, attacking chickens, turkeys, pheasants, and cage birds is the cause of a condition known as scaly leg. While this mite is usually confined to the legs, it may occasionally attack the comb and wattles. The disease occurs in most cases as a result of association with infested birds. It spreads slowly, and many individuals escape it entirely, although constantly exposed to it (fig. 26).

Symptoms.—The disease is easily recognized by the enlargement of the feet and legs and the rough appearance of the surface of the feet. The parasite begins its attack in the clefts between the toes and gradually spreads forward and upward until the whole of the foot and the shank become affected. The two legs are usually attacked about the same time and to the same degree. At first

⁷ For further information regarding this mite see Department Circular 79, Tropical Fowl Mite in the United States, with Notes on Life History and Control.

there is only a slight roughening of the surface, but the continued irritation by the mite causes the formation of a spongy or powdery substance beneath the scales, which raises them more and more until they are nearly perpendicular to the surface and are easily detached. In the most severe cases the joints become inflamed, the birds are lame and scarcely able to walk, a joint or an entire toe may be lost, and the birds, unable to scratch for feed, lose flesh and die from hunger and exhaustion.

Treatment.—The most effective treatment for scaly leg is to dip the feet and shanks of the infested birds in crude petroleum. This can be done most easily by putting the petroleum in a large bucket or tub. In dipping the feet, care should be taken not to get the oil on the upper part of the legs or on the feathers. If a large number of fowls are to be treated, it is best to do the work in the morning. This gives an opportunity for the oil to dry in and evaporate before the fowls go to roost. Another treatment which has its advocates but is more laborious is to wash the feet and legs with soap and warm water, removing all loose scales. Dry the legs and apply an ointment containing 2 percent of carbolic acid or 15 percent of fine sulphur, or a mixture of Peruvian balsam, 1 ounce, and alcohol, 3 ounces. When crude petroleum is not readily available, kerosene oil may be used as a dip for the feet. With the crude-oil treatment usually one application is sufficient, although in severe cases a second application 30 days later may be desirable. With the other remedies mentioned, a second treatment should be given 3 or 4 days after the first. To prevent the spread of the scaly-leg mites from fowl to fowl it is advisable to apply anthracene oil or crude petroleum to the roosts.

OTHER MITES

Several other species of mites infest poultry. One species bores into the skin and is found in cysts lying on the under surface of the skin next to the muscles. This form is not known to do any serious injury. Still another species occurs in the air passages, liver, and lungs of chickens. Unless present in sufficient numbers to interfere with breathing, it is not a serious pest. Still other mites live among the feathers of the birds, sometimes causing an unsightly appearance of the feathers, but apparently cause little injury to the birds themselves.

CHIGGERS, OR HARVEST MITES

Chiggers, harvest mites, or "red bugs", which so frequently annoy campers by the intense itching they produce, may also attack fowls. Young chickens having a free range, especially if it includes low-lying lands, are the most likely to suffer from these parasites. The mites attach to the skin, causing an intense itching, and abscesses may be found where clusters of mites are feeding. These abscesses are sometimes a third of an inch in diameter, surrounded by an area of inflammation. The birds become droopy, refuse to eat, and may die from hunger and exhaustion.

Treatment.—If an abscess has not yet formed, the inflamed area may be treated with sulphur ointment, Peruvian balsam, or a mixture of 1 part of kerosene with 3 parts of lard. If suppuration has

occurred the scab should be removed and the area washed with 4-per cent carbolic acid solution. Frequent light dusting with flowers of sulphur will keep the chickens from becoming infested. In the Southern and Central States, where harvest mites are most numerous, it is often necessary to keep young chickens off the range in summer. In these sections it is a good plan to hatch the chickens early in spring, so that when the warm weather comes, in which the mites are most abundant, the birds will be old enough to resist their attacks.

TICKS^{*}

In some parts of the South poultry are commonly infested with a species of tick known as the chicken tick or blue bug, *Argas miniatus*. This parasite when full-grown may be from one fifth to one fourth of an inch long and is a powerful blood sucker. In its adult stage of development it has feeding habits similar to the much smaller red mite, in that it feeds only at night and spends the days hiding in cracks in the roosts or walls. Pigeons are occasionally attacked by a similar tick, and both species have been known to inflict painful bites on persons coming in contact with infested birds. These ticks, on account of their relatively large size as compared with mites, can do a great deal of damage in a poultry or pigeon house, and young birds attacked by them are liable to succumb from loss of blood. Moreover, in the case of the chicken tick, it is known that in some countries this parasite may itself be parasitized by minute organisms which are injected into the blood of the fowl which it attacks, causing a severe and usually fatal fever. In this way the tick acts as a carrier of the disease organism much as the mosquito by its bites carries the organism causing malaria in man.

The first stage of the chicken tick's development is passed on the body, the seed tick leaving the birds when it has become engorged; thereafter the adult tick attacks chickens only at night, after they have gone to roost.

Treatment.—Chicken ticks are very persistent, and ordinary insecticides have little effect on them. If the chicken house is badly infested and is not of much value, it should be destroyed by burning. Otherwise, it may be disinfected after all loose boards and boxes which may provide hiding places for the ticks have been removed. Then anthracene oil, crude petroleum, or wood preservative may be applied as recommended for the treatment of red mites. After the general spraying it is usually necessary to apply anthracene oil to the roosts, roost supports, and nests several times at intervals of three or four weeks.

A simple and inexpensive way of protecting chickens from the attacks of ticks is to provide readily demountable roosts direct from the floor and not touching the walls. These should be painted occasionally with anthracene oil or petroleum. Nests should be located away from roosting places. If constructed of metal, they can be quickly rid of ticks from time to time by burning out the straw.

Metal houses have been found to be effective in dealing with the ticks, as even without special attention they remain practically

^{*} For additional details see Farmers' Bulletin 1070, the Fowl Tick and How Premises May Be Freed from It.

tick-free, and if necessary they can be disinfected easily by a fire of straw, paper, or other light material, after the removal of the roosts. Metal houses, however, are usually more expensive than wooden ones, and are hot in summer and cold in winter. If they are used in summer the fowls should be provided with shade outside the house.

When ticks have once been eradicated from the premises no chickens should be added to the flock until they have been quarantined for 10 days in temporary coops. The coops should be destroyed after use, or thoroughly treated with anthracene oil.

FLEAS^o

In the Southern and Southwestern States poultry are frequently infested by a species of flea known as the chicken flea (fig. 27) or sticktight flea, so called from its habit of remaining attached to one place. This form also attacks dogs, cats, and some wild animals. On poultry the fleas are usually found in clusters on the comb, wattles, and around the eyes; on dogs they are found on the ears. Young fowls when heavily infested often die quickly. Older birds, while more resistant, have been known to succumb to heavy infestations, and even mild infestations reduce egg laying and retard growth.

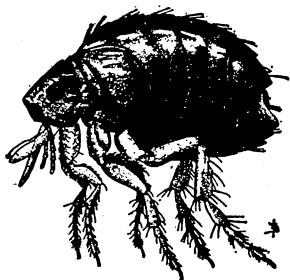


FIGURE 27.—The sticktight flea, adult female. Much enlarged.

Treatment.—As a preliminary step in the treatment of fleas, all dogs and cats should be kept away from the chickens and should never be allowed to lie on the ground in the chicken yards. As rats frequently harbor large numbers of these fleas and may therefore keep up the infestation, they should be destroyed by trapping, not only on account of the fleas they may carry but because they are themselves a serious pest to poultry. Chicken fleas breed in the dust on the floors of henhouses, and on the soil under houses and outbuildings. Hence especial attention must be given to the treatment of the breeding places rather than of the infested fowls. The combs and wattles of the birds may be anointed with carbolated petroleum or sulphur ointment. Great care should be taken, however, not to get any of the ointment in the birds' eyes, as it may produce blindness. The henhouses and yards should be thoroughly cleaned and sprayed with creosote oil. As the fleas breed freely in the dust beneath buildings, it is advisable to exclude poultry and animals from such places.

THE BEDBUG AND CLOSELY RELATED BUGS

The common bedbug, *Cimex lectularius*, and one of its close relatives, the Mexican chicken bug, *Haematosiphon inodora*, as well as the European pigeon bug, *C. columbarius*, and the barn-swallow bug, *Oeciacus hirundinis*, may attack domestic birds and may become serious pests. The bugs live in the nests or about roosting places, hiding in the cracks during the day and coming out at night

^o For additional details in regard to chicken fleas see Farmers' Bulletin 897, Fleas as Pests to Man and Animals, with Suggestions for Their Control.

to suck the blood of the fowls. They especially annoy sitting hens, sometimes causing them to desert their nests. Since they may gain entrance to houses and cause much annoyance to human beings, their control is doubly important.

Treatment.—These pests can usually be destroyed by the thorough spraying of all cracks of the poultry house with creosote oil or crude petroleum.¹⁰ Poultry houses should be built so as to eliminate, so far as possible, holes and cracks which offer protection to the bugs.

BEETLE LARVAE

There are several different kinds of beetle larvae which may occasionally attack domestic birds. Young pigeons especially suffer from such attacks. The larder beetle, *Dermestes lardarius*, and also the meal worm, *Tenebrio molitor*, have been known to kill squabs by eating away the skin at the vent and neck, thus producing serious sores; and larvae of one of the sexton or burrowing beetles, *Necrophorus* sp., may also attack these young birds. The adult of the meal worm, on the other hand, may greatly annoy sitting hens, attacking them on the feet. In addition, larvae of the blowflies, *Lucilia* spp. and *Cochliomyia macellaria*, may be found on domestic birds, the eggs having been deposited by the fly in sores or in the natural openings of the bird's body.

THE PIGEON FLY

In recent years the pigeon fly, *Pseudolynchia maura*, has become a serious menace in many parts of the United States, especially in the Southern States. The flies annoy the pigeons and, when numerous, their bites cause considerable loss of blood; in addition, they transmit the organisms which cause pigeon malarie. See page 44 for details in this connection and for control measures.

¹⁰ For additional details in regard to the bedbug and its control see Farmers' Bulletin 754, The Bedbug.

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